THE

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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893

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THE ELECTRIC CURRENT.

OUR transatlantic contemporary the *Electrical World*, has recently been publishing a series of articles, by Mr. A. Stoletow, on "Ether and Electricity." The second article is devoted more especially to a consideration of recent theories of the electric current, but we hope it is not typical of the state of knowledge in America on this interesting and important subject. Mr. Stoletow's modern views are for the most part hazy, and where they are not hazy they are often inaccurate.

Take as a sample the following: "We find that the lines of electric and those of magnetic force cut each other at right angles. The field is thus divided into zones or tubes of force." What has the perpendicular intersection of the lines of magnetic and electric force to do with the division of the electric field into tubes of force? Still more obscure is this extract from Mr. Stoletow's article: "We might construct these tubes of force so that their density (the number of lines of force passing the unit section of the tube) shall at each point of the field be proportional to the intensity of the force." Apparently what the writer means is, that if lines of force are taken to represent unit tubes of force, the number of lines passing through a small unit of area will be proportional to the intensity of the electric force over that area.

The writer proceeds to explain the views of Faraday, Maxwell and Poynting upon electrostatic and electro-magnetic phenomena: "Faraday has already represented each tube of force of the electro-magnetic field as stretched along its length and pressed on its sides by neighbouring tubes. . . . Maxwell has shown that this idea of the electromagnetic field corresponds exactly with what actually happens." From the above statement of the case, Maxwell and Faraday would appear to most of us to have exchanged their usual parts. Coming next to the views of Poynting, one of Maxwell's pupils, Mr. Stoletow explains that they indicate that "metallic conductors are the destroyers, the extinguishers, of electro-magnetic energy. . . . . Poynting claims that the energy of a voltaic current is propagated in the dielectric medium, ordinarily the air; so the line of this propagation forms a right angle with the lines of electric and magnetic forces." So far, we take it, this is a fair representation of Poynting's theory, but he continues: "Partly, this energy glides, so to speak, *along metallic surfaces*: partly goes through the surrounding medium, and meeting a metal penetrates to different depths, changing into heat." It is unnecessary to point out that this is a travesty of Poynting's theory of the flow of electric energy in the voltaic circuit.

The theory of the electric current deduced by Poynting from Maxwell's equations of the electro-magnetic field, since it was popularised by the publication of Lodge's "Modern Views of Electricity," has been much in evidence. It has received the support of leading mathematicians and physicists, such as Lodge and Heaviside, and recently gave rise

to a brilliant controversy in the pages of a contemporary, in which the balance of the argument appeared to be in favour of Poynting's view. This view may be shortly stated to be that the electric energy in the voltaic circuit does not flow through the conductor, but passes from the source of electromotive force, along equipotential surfaces in the dielectric, till it enters the conductor at right angles at all points along its length, where it is dissipated in the form of heat. This new view of electric current was sufficiently startling to the average electrician who had been educated to believe that the conductor was the carrier of the energy of the electric current, and it accordingly met with considerable opposition, as being another fad of the theorist.

The fatal objection to Poynting's theory appears to us to be that the premises on which the mathematical proof is based are incorrect. This, of course, is usually the weak point in mathematical theories. When Maxwell propounded his epoch-making generalisation that light and electricity were merely different modes of motion of the same medium, viz., the so-called luminiferous ether; the luminiferous ether as elaborated by Green for the theory of light appears to have been imported without change into the theory of electricity. It is well known that Green's investigations were founded on the assumption that the ether was an elastic solid. This assumption led to correct explanations of most of the phenomena of light, but to show that even in this field it was not entirely satisfactory, it will be sufficient to note that Lord Rayleigh remarks when discussing the wave theory of light that the elastic solid theory of light is objectionable, because it implies the existence of longitudinal as well as transverse waves, and that of the former there is nothing known in optics; he considers that the elastic solid theory of light can only be regarded as an illustration.

Seeing that Green's theory of the ether has led to some false conclusions in the theory of light, it is not to be relied on when applied to electric theory in cases where the results cannot be tested by experiment. This appears to be the case with this new theory of the electric current. There is only one experimental fact, as far as we know, which appears to lend any support to this theory, and that is that alternating currents tend to flow on the surfaces of conductors; but this we think can be explained equally well by the dissociation theory of the electric current, which, in the hands of Ostwald, J. J. Thomson, and others, has already shown the promise and potency of great discoveries.

THE CAREY-FOSTER SLIDE-BRIDGE.

THE attempt to attain "the fifth decimal" in the comparison of resistances has led to a steady development of the slide-bridge method of Prof. Carey-Foster. The direction in which improvements have come has been principally in the manufacture of the wire itself, to ensure its being uniform in gauge and resistance, and of the right degree of hardness. On the other hand, much has been done to simplify the means of commutating the coils, and, at the same time, to perfect the contacts at all points of junction.

Quite recently, Mr. Elmer G. Willyoung has read a paper before the Franklin Institute upon "Some new Apparatus for the most exact Comparison and Adjustment of Resistance Standards, and the Determination of Temperature Coefficients," in which he tells his American colleagues of the advances *he* has made in this direction, and of the apparatus *he* has designed for the purpose. *His* first commutating device, be it said, is practically identical with that of Dr. Silvanus Thompson, as illustrated in the text-books; and his cylindrical arrangement of bridge wire is as nearly a copy of Clark's potentiometer as anything that could be imagined. Nevertheless, the paper is a very interesting one, and if we grumble at the little omissions, we have equal reason to appreciate the small improvements in detail which Mr. Willyoung claims to have accomplished.

For the purpose of measuring the resistance of the bridge-wire in terms of the resistance of the standard itself, the method of shunting the fixed coil by the standard is used; the gap of the other fixed coil being short-circuited by a copper strap. In order to place the two coils in multiple arc, some double mercury cups are wanted; in the form given to Dr. Thompson's commutator by Mr. Willyoung, these mercury cups are disposed upon the board in such a way as to produce a symmetrical arrangement of the connectors, whether the single coil or the parallel coils are being used during the measurement. There is nothing very novel in this device, but it may commend itself on the ground of neatness.

Mr. Willyoung hopes to get rid of many of the attendant evils of the slide-bridge by the cylindrical rheostat. The advantages claimed for this form of bridge are that it brings the readings where they can easily be read; it occupies less space; the ends of the wire are close together, so that there is practically no difference in temperature between them; and, lastly, the form is necessarily such that the wire cannot pull out of the end junctions. Anyone who uses a slide-bridge will be glad to avail themselves of an instrument that will be free from thermal currents; but we think that the difficulties will scarcely vanish by coiling the wire round a cylinder. The difference of temperature between the two ends will hardly be diminished by placing them a foot or two nearer together; the difference in temperature is not simply a matter of relative position in space; it is greatly a matter of air currents, which can usually be diminished by wrapping the ends of the slide wire in cotton-wool, and by taking care not to stand too close to the bridge. The best way of eliminating the errors is, of course, to reverse the battery, and take the mean of the two readings.

It is doubtful whether the cylindrical arrangement permits of such accuracy in reading as does the straight wire. The Clark's potentiometer, which Mr. Willyoung uses for this purpose, is an ebonite cylinder, on which a screw is cut, the wire being wound within the screw groove. An ordinary wheel contact forms the jockey, and is carried along a horizontal graduated bar. Fractions of a revolution are read off at the ends of the cylinder. Now, unless the end graduations are perfectly in gear with those on the horizontal bar, there will be serious error; and again, it is very difficult to cut a long screw in ebonite in such a way as to ensure that the turns of wire laying in the grooves will all be equal. The use of the rolling-wheel contact is claimed as an advantage peculiar to the cylindriform slide-bridge, as it is not liable to injure the wire, as are most of the cutting knife-edge contacts on the usual form of straight bridge.

But why not use a wheel-contact, with a straight wire? It would not be an original design, but it might be a useful one.

Electric Lighting of Strasburg.

MR. OSCAR VON MILLER, as consulting engineer to the Municipality of Strasburg, deals with a series of alternative projects of lighting this city by electricity. Each project deals with the capital expenditure and working expenses for an original installation with 11,500 simultaneously burning 16 C.P. lamps, and an eventual extension of the same to 34,400 incandescent lamps of 16 C.P. The various projects fully described and splendidly illustrated by means of large plates and diagrams, are as follows:—1. An installation with alternators and transformers using steam power. 2. A continuous current plant containing accumulators worked by steam power. 3. A plant with alternators and transformers using the waterpower of the Rhine; also steam power as reserve. 4. A continuous current plant and accumulators, with alternate current and continuous current motor generators, using the water-power of the river, and steam reserve. All these projects appear to be worked out with great care and completeness, and they would form an excellent model for many of our consulting engineers.

Electricity and Vegetation.

THE action of electricity on vegetation would appear to be a simpler matter for study than its action on animals, for the life-processes are by no means so complex. Yet we have made comparatively little progress in our knowledge of this obscure subject. It is not that scientists have neglected it; nor that faddists have had the field to themselves. The historical review given by *Electricité* last year shows that competent attention has been devoted to experiments with electricity on vegetation. These experiments have been of two orders, the static and the dynamic; the former was generally favoured by the early investigators, but now a modified system of examination combining some of the advantages of the static and dynamic methods appears likely to be extensively used. And, perhaps, we may now reasonably hope that the action of electricity in repressing or accentuating the life processes of plants may soon be better understood. *La Lumière Electrique*, in its usual cosmopolitan way, devotes several pages to a consideration of the results of some of the more recent researches on electricity and vegetation. Lemstrom's experiments at Helsingfors, Lewis's at Bourgogne, and Spechnew's in Russia are cited; and then after discussing Brutini's contradictory observations, an account is given of some recent investigations by Lagrange and Paulin. These were made on an extended scale; many have committed the error of drawing conclusions from mere laboratory observations. But what is the upshot? We learn that electricity undoubtedly has an action upon vegetation, but that no light is thrown upon its mode of action. Just so. And we are precisely where we were before these experiments were instituted. If electroculture is ever to be founded upon an intelligent basis, the attention of those who investigate it must be differently directed.

Practical Farming by Electricity.

SUCH is the title of an article by A. F. McKissick in the *Engineering Magazine* (New York). The writer has evidently come fresh from a visit to the Alabama Agricultural Experiment Station at Auburn, where he has seen a large number of farm operations performed by electricity instead of by steam, &c., and he is so profoundly impressed with the idea of practical farming by electricity, that he sees in its application a solution of the problem of agricultural depression. He goes farther and looks at what he terms "the social side." He says: "It would cause neighbouring farmers to work into each others hands, all pulling together like a pack of horses. It would bring them (the farmers or the horses?) into closer intercourse with each other." If electricity can do all this, it will be as great a humanising agent as it promises to be an instrument of civilisation. The writer seems to have ridden off at such a rate upon his hobby, that we almost hesitate to take him seriously. He illustrates his article, however, with some pleasing pictures of cotton gins, threshing machines, corn shellers, ensilage cutters, &c., run by electricity, and of the electrical machinery; but of the installation, and the method of working, it is impossible to obtain an intelligent notion. The particulars of cost strike one as a little ingenuous in their arrangement, to say the least of them, but the writer carefully avoids committing himself. Uncle Sam likes to have "experimental stations," and it would be a good thing perhaps if John Bull were a little more given to this method of investigating matters of national interest. But we wonder now what might be the actual cost of a bushel of corn raised on the Alabama station.

Electric Railway Signalling.

AN apparatus has lately been invented by A. C. Millwaters, and recently demonstrated in the presence of members of the Yorkshire press, which is prescribed by the inventor to fulfil the recommendations to railway companies embodied in the report of Major Marindin on the Thirsk railway accident. A perusal of extracts from the patent specification, gives us the opinion that the apparatus cannot be calculated to be of any great service. It is unnecessarily complicated, and it is questionable whether in practice, it would work at all. It is possible and very probable, that in winter, the oil would thicken or even congeal, but there is a bare possibility that in moderate temperatures it might be operative. To enable the apparatus to work there must be compression of rail; and if such is obtainable, then why not employ it to make direct electrical contact rather than use it to tip a lever for doing so?

The E.M.F. of Oxidation Cells.

THE electromotive force of oxidation cells is an additive property, that is, it is equal to the sum of two terms, one depending upon the nature of the oxidising agent, and the other on the nature of the reducing agent of the cell. If the electrodes are not attached during the reaction in the cells, the electromotive force is independent of their nature; and it is also, within wide limits, independent of the concentration of the solutions. The nature of the solution which effects the electrolytic connection is without influence on the value of the electromotive force. Such are the general conclusions arrived at by W. D. Bancroft in a recent investigation of this subject. His method was essentially as follows:—Two test tubes, one containing an oxidising solution, the other a reducing solution, had their contents electrolytically connected with each other by means of side tubes and an inverted siphon filled with a solution of sodium chloride. Electrodes of platinum cut from the same piece of foil were immersed in the liquids, and the electromotive force between them measured by means of a galvanometer, a Latimer-Clark cell being used as the standard. No less than 17 oxidising solutions and 24 reducing solutions were placed under examination before the above deductions were made. The general concentration of these solutions was $\frac{1}{3}$th normal, whilst the temperature was between the limits 16° and 18° Centigrade. Bancroft observed that a free acid is a stronger oxidising agent than its alkaline salts, but that the converse holds true for reducing agents. Under the restrictions already mentioned, the electromotive force of oxidation cells, is in general, independent of the nature of the indifferent ions. The electrodes are apparently not always non-polarisable as theory requires; the variations may, however, usually be attributed to secondary influences.

THE APPLICATIONS OF OZONE.

[FROM A CORRESPONDENT.]

(*Continued from page* 209.)

Dr. C. Fox has been still more confident of the virtues of ozone, and he advocates its uses in hospitals, saying that it should be diffused through fever wards, sick rooms, the crowded localities of the poor, or wherever the active power of the air is reduced and poisons are generated. "Its employment is demanded in our hospitals, situated as they mostly are in densely-populated districts, where the atmosphere is almost polluted by re-breathed air, decomposing substances and their products, and when no mere ventilation can be fully effective. *If practicable*, it would be highly advantageous to direct the *stream of sea air, or air artificially ozonised*, into the fever and cholera nests of our towns. Ozone may be easily disseminated through public buildings, theatres, and other confined atmospheres where numbers of people are accustomed to assemble, in order to maintain the purity of the air."

There is a great deal to say about the peculiar odour of ozone, which has been called by some people very fond of it, a refreshing, bracing, pungent, and exhilarating smell, and has been compared by others to the smell of phosphorus or of lobster, or of silex struck by steel. Like all fragrant odours or perfumes, it is very pleasant when not in excess, but, *ne quid nimis!* as soon as there is too much Ozone it loses its charms. The worse odours may be agreeable when in infinitesimal parts; the perfume of roses or of orange blossom is unbearable when inhaled from a concentrated essence, so with ozone.

Ozonised air is used in the United States for ventilating habitations, public buildings, and places where people are crowded together, like theatres, public assemblies, &c. Water is ozonised in the following manner:—

Oxygen contained in large iron cylinders, under pressure, is first washed and dried, and is passed through Siemens tubes, where it is ozonised to the extent of 15 per cent.

This ozonised oxygen is sent through tin pipes into earthenware receivers in the shape of cylinders, 6 feet high and 3 in diameter, and full of distilled or sterilised water, containing 4 to 5 per cent. of certain phosphate salts.

In these reservoirs are disposed 26 terra-cotta sieves, the holes of which are very small. Under a pressure of about five atmospheres, the ozone is introduced at the bottom of these cylinders, and is forced like a spray through the sieves, so that it is absorbed by the water, in which it is stated, it is rendered stable by a patent process. These cylinders are kept at a low temperature (at least 10° C.), by means of ice.

For ventilation purposes, the ozone appliances consist of an electric motor, having a fan at one end of the armature shaft.

The motor is in the lower part of a case, about 2 feet square and 3 feet high; there is a constant suction maintained.

The air is first led through a drying tube, then through a series of ozone tubes, from which it passes out, and is carried by tin pipes along the upper part of the space to be ventilated.

I will now give an extract of a very long article written by Aug. Schneller in the *Elektrotechnische Zeitschrift* about Ozone and its applications, but I must warn the reader against the accuracy of his calculations, which seem to be based on theory and hypothesis, and not on facts.

"According to Berthelot, the tonality (warmetöning) of Ozone is 29,600 calories, says Mr. Schneller, and, therefore, as 1 kilog. cal. = 1·156 watt-hours, it would follow that the production of 1 kilo. of Ozone would require 3·48 H.P. hours. But if we deduct the loss of energy calculated on an efficiency of 85 to 90 per cent., we find that 1 kilo. of ozone requires 4 H.P. Taking the H.P. hour at 3 pfennigs (100 pfennigs = 1 mark, say 1 shilling), 1 kilo. produced by the electrification of the Ozone of the air costs 20 pfennigs.

"The solution of the problem of the cheap production of Ozone involves a complete revolution not only in the bleaching industry, but in the refining of sugar and in technical chemistry; and the productions of anhydrous sulphuric acid, of nitric acid, as well as numberless applications of Ozone to organic chemistry, and to the chemistry of colours, are merely a question of time.

"When atmospheric air is ozonised instead of pure oxygen, nitrous compounds are formed, which render impossible the application of Ozone, so produced, to certain purposes; they are prejudicial not only in bleaching textiles, but in purifying sugar, which becomes acid.

"The action of nitrous compounds on some fabrics is very injurious, and it destroys the fibre in a very short time; the worst is that it is almost impossible to separate nitrogen from Ozone."

M. Schneller has devoted part of his paper to bleaching by means of ozone, but he confines himself to generalities on natural Ozone, chlorine, and the advantages of Ozone, and when he quotes figures he does it in a very rash way. On what authority can he say that 5 grammes of Ozone will bleach 1 kilo. of cotton, and that 20 to 30 grammes will bleach 1 kilo. of flax?

The same incredulity will meet the following calculations, according to which 1 H.P. hour, costing 5 pfennigs, is capable of producing 6·25 kilos. of Ozone, and that 1 kilo. of chlorine costs 50 pfennigs (6d.), which is much dearer than Ozone, which bleaches four and a half times more than chlorine, and costs but 20 pfennigs.

The mere statement that the bleaching of sugar does not require more than 15 to 20 grammes of Ozone per kilo. is not only insufficient but unreliable.

We wish the above quoted figures were accurate.

As regards the Schneller ozoniser, there is not much new in it; it is simply an adaptation of the Babo ozoniser, as he declares himself (*Elektrotechnische Zeitschrift*, 1890, p. 591, Vol. 1: *Diese Anordnung ist dennach eine Verbesserung der alten Ozonröhre von v. Babo*). This apparatus is therefore an improvement of the old Ozone tube constructed by von Babo.

Before handling the subject of the commercial application of ozone, produced from atmospheric air or from oxygen by means of dynamos and transformers, I must enter into a few details and explanations regarding the first ozonisers made during the last 40 years, and their description will show that practically the construction of the modern commercial ozonisers is based on the same principle as the small laboratory apparatus in which, years ago, a gramme of ozone was only formed with extreme difficulty, the only difference being that, instead of a battery a dynamo is now used, and that the modest induction coil has been replaced by a transformer, which can hardly be called a transformed coil.

A great deal has been said on the origin of transformers, but I am not sure that it is commonly known that the first application of a dynamo to a Rhumkorff coil used as a transformer of low tension into high tension for producing ozone, was made by Dr. W. Spottiswoode in 1875.

I have lately tried, says he (*Phil. Mag.*, 1875, p. 390), a mode of exciting an induction coil which I *have not seen elsewhere described*, and which appears to promise valuable results. It consists in connecting the primary circuit directly with a dynamo giving alternate currents. I have used one of M. de Meritens's excellent machines, driven by a 3½ H.P. Otto silent gas engine. The speed of dynamo so driven is 1,300 revolutions per minute. The advantages of the method are:—

1. That, as the machine effects its own make and break, both the contact breaker and the condenser of the induction coil can be dispensed with.

2. That the breaking of the primary, and consequently the delivery of the secondary currents is perfectly regular.

3. That the *quantity of the currents* in the secondary *is very great.*

With a 20-inch coil by Apps, I have obtained a spark about 7 inches in length of the full thickness of an ordinary cedar pencil. But for a spark of thickness, comparable at least with this and of 2 inches length, an ordinary 4-inch coil is sufficient.

Eleven years after, the *English Mechanic* published a letter signed by P. Ward on manufacturing ozone in a large volume by a special process discovered, said the writer, "by the late W. Spottiswoode, F.R.S., and myself."

This apparatus or ozone generator, according to Mr. P. Ward himself, was *not new*, and consisted of a wooden box 1 foot by 6 inches by 2 inches inside measurement. It had a tightly fitting cover and a round hole about 1 inch in

diameter at each end, into which were fitted short lengths of ebonite tube about 2 inches long for connecting it to an aspirator or pump for forcing the air through the box.

The interior of the box, which was well varnished with shellac and then paraffined, was a series of celluloid plates about $\frac{1}{16}$th inch thick and kept apart (by fillets of the same material $\frac{1}{16}$th inch thick). These sheets reached not from end to end of the box, but were about 1 inch short of each end. Each sheet had a piece of tinfoil attached to its upper surface with a small "lug" at one corner. The celluloid was then coated (tinfoil and all) with a thin coat of paraffin wax, to protect the foil from the chemical action of the ozone. The air was forced and passed in thin "slices" between the tinfoil armed sheets of celluloid. Every sheet of even number, 2, 4, 6, &c., had its "lug" of foil connected to a common binding screw, and the "lugs" of uneven number were connected with another binding screw.

"The only features I claim to be novel in such an apparatus," said P. Ward, "are the use of *celluloid* plates, as being in every way superior to glass or ebonite, both for physical properties and cheapness, and on the protection of the foil by paraffin." On this point, I would take the liberty of disagreeing altogether with Mr. P. Ward, because the heat developed between his thin slices in his ozonator would certainly affect, in a distinct manner, the insulating properties of his favourite dielectrics, which undoubtedly would melt.

The end of the letter is devoted to a description of the new arrangement of the coil in combination with a dynamo (2 H.P., 5 ampères, 300 volts), and I extract from it the following very interesting statement :—

"It will be seen at what an enormous speed air can be forced through the generator, when we take into consideration that one discharge, for the contained air in the chamber, is sufficient to materially ozonise it. It means that, taking the air bulk to be one-third the cubic contents of the box, we can drive through 48 cubic inches of air 40,000 times in one minute, or, roughly speaking, 1,111 feet in one minute; or, supposing we gave the air four electrisations instead of only one, we should still get 277 feet of well ozonised air per minute.

"Our improvement consists in doing away with all complications of contact brakes, condensers, &c., and employing a single primary and secondary, and that is all, and delivering into the ozone generator not 4,000 currents per minute, but 40,000 or more.

"I have made gigantic experiments in this direction in the laboratories of the late Dr. Spottiswoode, and have had as much as 12,000 watts running through the primary and secondary current of one of his large induction coils."

What I am and many others will be at a loss to understand, is that Mr. P. Ward waited till 1886 to speak of this process *discovered jointly by the late W. Spottiswoode and himself*, while in 1875, Dr. Spottiswoode, in his paper to the Royal Institution, said that *he had discovered it*, and omitted to mention that it was jointly with Mr. P. Ward.

Dr. WERNER SIEMENS, 1857.

The late Werner Siemens was the first, in 1857, to construct an ozonising tube, which he fully described in his paper on "Electrostatic Induction" (*Annalen der Physic and Chemie, von Poggendorff*, Vol. cii., page 120). The drawing published in the *Poggendorff Annalen*, resembles in its shape the ozoniser patented by Siemens and Halske in 1891, which, later on, I will publish; but several books represent it as follows :

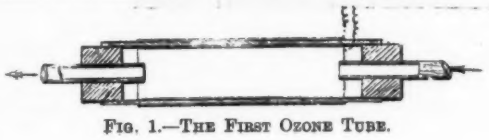


FIG. 1.—THE FIRST OZONE TUBE.

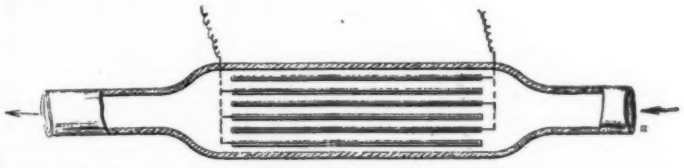
It consists of two tubes made of the thinnest glass, inserted one in the other, so as to leave an annular space between them, through which the air or oxygen passes, and is ozonised under the action of the silent discharges which are produced by a Wagner induction coil, the two poles of which are connected with a tinfoil armature coating the inside of the inner tube and another tinfoil armature coating the outside of the outer tube.

The ozoniser then becomes luminous, stated W. Siemens, the air is ozonised, and it can be easily renewed by being blown through the inlet tube. Then large quantities of ozone are produced.

One can hardly help smiling when reading this statement about "*large quantities of ozone*" *in a Lilliputian tube*, made by the great electrician and constructor of powerful and gigantic engines.

VON BABO, 1863.

The tube invented by Von Babo (fig. 2) is very little known, but has been imitated by several electricians who re-invented his apparatus, which consists of a bundle of 12 very small thin glass tubes, 3 mm. diameter, each containing a copper wire. Six of these are connected with one of the terminals of an induction coil, and the remaining six with the other terminal of the coil. The twelve tubes are placed in a glass tube of about 6 to 10 mm. diameter and about 1 metre long. The air, admitted at one end, surrounds the glass tubes and flows out at the other end. The metallic conductors are separated by the glass and a layer of air which is charged with the electricity of opposite signs when the discharge takes place.



An even number of thin glass tubes, each containing a copper wire. One-half are connected to one terminal of an induction coil, the other half to the other terminal.

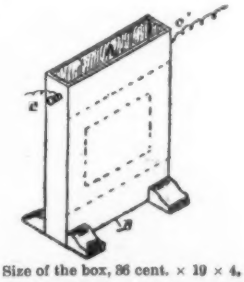
FIG. 2.

The following remarks on this apparatus by Mendleyeff deserve special attention :—"A silent discharge is a combination of opposite statical electricities which takes place regularly without sparks, slowly and quietly (as in the dispersion of electricity).

"Von Babo's apparatus was one of the first constructed for ozonising oxygen by means of the silent discharge, and it is still one of the best."

BEANE'S, 1868.

Mr. de Luynes exhibited in Paris, in 1868, at the Societé d'Encouragement, an ozoniser in the shape of a condenser (fig. 3).



Size of the box, 36 cent. × 19 × 4.

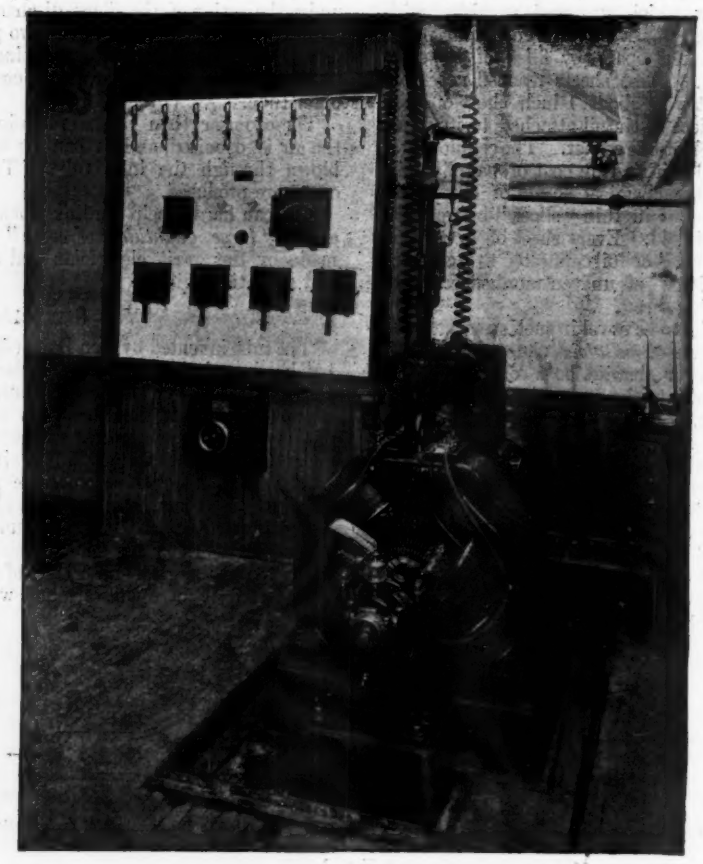
A, Upper opening; B, Lower opening; C, Binding screw connecting one portion of the coil to sheets 1, 3, 5 of tinned glass; D, Binding screw connecting the other portion to sheets 2, 4, 6.

FIG. 3.—CONDENSER, IN WHICH THERE ARE SIX GLASS PLATES COATED WITH TINFOIL.

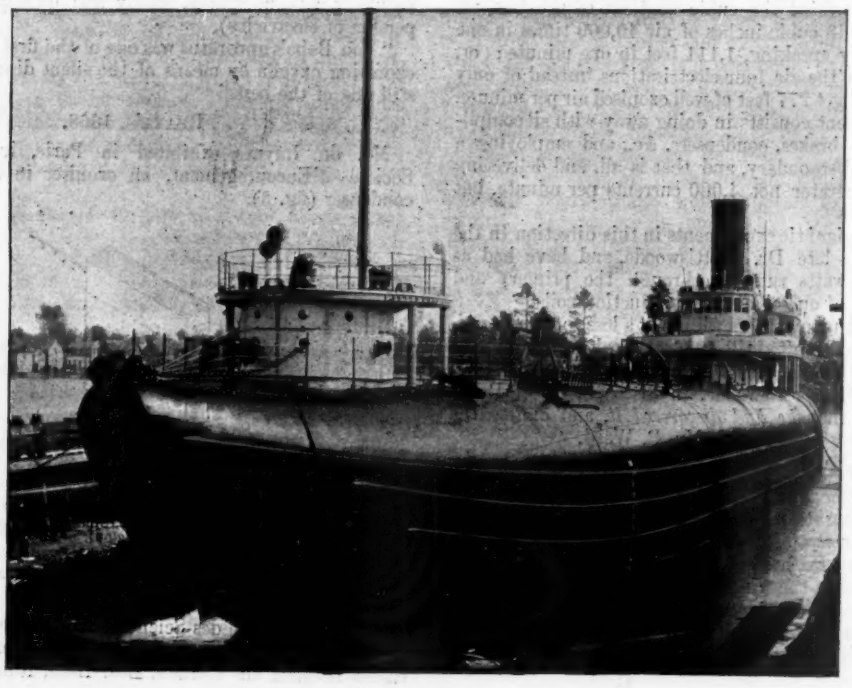
At the Academie des Sciences, Saint Edme and Lhote read some papers on this apparatus, which by some strange confusion is called the Beane's, Bear Beed, Rhumkorff or Ladd ozoniser.

(To be continued.)

ERRATUM.—Page 208, column 2, line 14, for 7 gr. 64 per hour, 183 gr. 36, read 8 gr. 64 per hour, 203 gr. 36.



Ship Lighting Plant on Board the "Pillsbury."



The "Pillsbury."

AMERICAN SHIP LIGHTING PLANT.

THE special advantages of the combination generating set, a description of which has been sent to us by the New York General Electric Company, also an exemplification of their use on shipboard, comprising dynamo and engine compactly erected on one base, are strikingly displayed in the plant which we illustrate.

This is the first electrical plant ever placed upon a steamship of the whaleback type, and was installed on the *Pillsbury*, when building at West Superior, Wisconsin. Considerations of space entered largely into the question of the installation, and a small room, 8 feet square, was all that could be spared. This precluded the employment of a belt-connected plant, and a generating set of the Thomson-Houston International Company type was therefore adopted.

The dynamo is of 150 lights capacity, and is directly coupled to a 15-H.P. engine, both having a common bed plate. Under exhaustive tests the engines showed the highest possible economy obtainable from machines of this size, and its simplicity is such as to reduce the attention necessary to a minimum.

The generator is of the familiar quadripolar type, compound wound, having a regulation automatic, within 2 per cent. over the entire range from no load to full load.

The commutators are cross connected, so that only two brushes, 90° apart, are used. The rheostat is of the new, iron frame, incombustible type. The engine and dynamo are both provided with self-oiling bearings. Behind the engine and attached to the wall is the white marble incombustible switchboard. The dynamo room is located in the after portion of the vessel on the first lower deck.

The vessel is wired in the usual manner for 150 lights, the best grade of wire for marine purposes being employed.

The installation on the sister whaleback, the *Washburn*, is of a similar character.

THE GOEBEL DEFENCE.

THE case of the General Electric Company *versus* the Beacon Vacuum Pump Company is still in progress. In our issue of last week we announced that no further evidence was to be admitted and the briefs were to be printed. On resuming the proceedings, however, Mr. Witter, for the defendants, asked leave to introduce certain fresh exhibits and affidavits which could not be presented at the former hearing by reason of the short time allowed for preparation. This course was strenuously opposed by counsel for the plaintiffs, but after some discussion the Court decided to admit the new matter, and it was further intimated that should the case turn upon it, reasonable time would be granted to both sides to file additional affidavits in reply and rebuttal if desired. A perusal of these affidavits must cause not a little pain to anyone with a sensitive regard for veracity and rectitude of character. In a second affidavit the claimant, Henry Goebel, asserts amongst other things that he settled upon bamboo as the best material for filaments prior to 1872. He had at that time made four instruments for dressing thin threads of bamboo, and in 1886 sold three of them to Mr. C. G. Perkins (two of which were admitted in the present case as exhibits). He had a glass-blowing machine in his house also prior to 1872, and had made hundreds of barometers, thermometers, Geissler tubes, &c. Was a practiced glass-blower when he went to Grand Street (1872), but on joining the American Electric Company gave the glass-blowing to others to do, as he was then less practiced. In exhausting lamps by the Torricellian process had always used distilled mercury and performed the operation in a very dry atmosphere, and it was owing to these precautions that no traces of mercury remained inside the lamps. Had used a mercury pump prior to 1872. Deponent's lamps were fit for commercial use, but there was no source of cheap electricity at the time. He has received no valuable consideration for anything he has done for the defendants, and does not expect or desire any; has given evidence only after urging; has no enmity against Edison, does not know anyone connected with the defendant company, and has no interest in the result of the suit.

Compare this affirmation and Goebel's preceding one, which we abstracted in a former issue, with the following abstract of Mr. William McMahon's affidavit presented by the complainants. Deponent, with E. M. Fox and George Crosby, organised the American Electric Light Company early in 1881, started a small shop, and tried unsuccessfully to make lamps. Crosby spoke several times of an old man named Goebel, whom he thought would prove useful in the business; went with Crosby and others to see him; found him familiar with all the work that had been done up to that time in electric lighting. He regarded Edison as a great inventor. Showed deponent an arc lamp. Asked whether he had made an incandescent lamp, he replied he had not, but thought he could make carbons for them. Saw a mercury pump, but does not remember anything being said about it. Told Goebel that he could make him a very rich man if he could show an incandescent lamp made prior to Edison's; Goebel replied, "Well, we might make one that would look old, eh, George," which raised a general laugh. In 1881 there was intense excitement about electric light. There was every reason, then, for the interest of Goebel and his son to disclose everything he might have done in the way of making lamps, if he had done anything.

Several other important affidavits were put in on both sides, some of those introduced by the complainants tending materially to strengthen their position. Those referring to monetary matters are not without significance in view of the small concern Goebel now manifests with regard to obtaining money. Mr. W. C. Dreyer deposes that in the spring of 1882 he undertook to form a company, and procured an option from Goebel for $500 to acquire all his inventions in electric lighting. He was to have a large compensation if the undertaking was successful. The only inventions he had applied for patents for, were the mercury pump and a spiral carbon holder for incandescent lamps, though he claimed to have made lamps of the "fiddle-bow type" several years before. Goebel was unable to find one of these lamps. Got Goebel to extend the option for three months for an additional $450. His failure to produce any old lamp, and his general unreliability, caused deponent to distrust him, and at the expiration of the option let the matter drop, having lost his investment of $925. Is certain Goebel would have produced lamps if he could. Deponent, in conjunction with others, also approached the Edison Company. The whole matter was gone into, the conclusions being summed up thus:—"Even if Goebel did what he claims, it is nothing but an abandoned experiment." The company did not even deem him of sufficient importance to get him out of the way. Major S. B. Eaton (of the Edison Company) corroborated Mr. Dreyer's statement, and, in addition, declared that in November, 1882, H. Goebel, jun., called and offered his father's inventions for $20,000. The company considered the matter, and declined to purchase at any price. Otto A. Moses deposes to Goebel having, in 1884, confidently asserted that he made incandescent lamps a great many years before, but said he had none to show. Albert Hetchel, a glass-blower, deposed to having been in the employ of the American Electric Light Company in the summer of 1881, and worked at Goebel's shop every day for four months, helping to make incandescent lamps. Goebel knew very little about lamp manufacturing, and tried to make filaments out of old paper. He had a crude vacuum pump; made four little lamps from pieces of carbon from Maxim lamps. Had never said anything to him, deponent, about ever having done anything with incandescent lamps before Edison; never heard of his claims to priority until within the past week. Ludwig Böhm, who had been assistant to Mr. Edison in 1879, became superintendent of the American Electric Company in 1881; knew George Crosby and Goebel; latter never told him he had made lamps before Edison. Deponent got the impression that Goebel was eager to obtain money, and thought if he had so important an invention, he would certainly have presented it to the officers of the American Company. Affidavits were also added by friends and acquaintances of Goebel who had looked through his telescope, but had never seen any electric lamps. Had seen oil lamps on his waggon.

Some of the testimony of the respective deponents on this side contradict one another to a certain extent, it is true. Thus they are not all agreed as to the early claim (1881 or thereabouts) made by Goebel to the invention. Neither

are those who visited his shop, agreed as to what they saw, one having seen some carbons there, while others had not. All who visited him, however, are at one with regard to having seen his mercury pump, and we should like to know from them what they supposed he needed it for? This fact of the pump weakens their ground to some extent, though it is possible, of course, it was used solely for making aneroid barometers, or Geissler tubes. Still, under the most favourable interpretation for Goebel, the complainant's affidavits seem to show that he was not much more than a dabbler in this direction at best.

On the defendant's side a total of 31 additional affidavits were filed, and another lamp of the hairpin type, which was of superior workmanship and still preserves its vacuum, was put in as an exhibit. The electric circuit of the lamp, however, is not perfect. The various deponents testify to having seen Goebel's lamps at early dates, to his acquaintance with the details of lamp construction, to his good character and integrity, and generally corroborate the previous affidavits. One of the witnesses, a glass-blower named A. F. Heger, deposed to having been engaged by the American Electric Company in May, 1881. Frequently worked at Goebel's shop, where carbons were made; Goebel on one occasion showed him some old lamps, like the exhibits, that he kept in a safe. Two *sound* lamps, recently made by the defendant company, containing leading-in wires of iron sealed directly into the glass, were also put in.

In the face of such conflicting evidence, not subjected to cross-examination, it would be hazardous to venture on a definite opinion as to where the truth lies. But viewing the matter generally, it seems hardly likely that an artizan who cannot, on his own assertion, even read, and almost unaided, should amass the technical knowledge necessary to make incandescent lamps. Let us briefly consider a few of Goebel's own statements with a view to gleaning some light, if possible, as to the truth of his claims:—"The first lamps I *made* of this kind [the meat-saw type in the early fifties], were made from Cologne bottles, and afterwards I made them from tube glass." We should have thought that even practised lamp glass-blowers of the present day would find considerable difficulty in preparing a lamp for exhaust made with such a bottle containing leading-in wires of iron, and a long exhaust tube joined to the bottom or side of the vessel. Joining a glass tube firmly on to a vessel of another description of glass is not always an easy matter. In another part we find, "After gas was laid through Munroe Street some of the employés of the gas company would sometimes come in to see my lamps burning. These men became so suspicious that I was stealing their company's gas, that they insisted on going down into my cellar to investigate [for a gas meter, we presume]. I would not show them my battery and its connection with the lamps." How and where, we would inquire, was the glass blowing done when making the lamps? Did Goebel anticipate Mr. Thomas Fletcher's gazoline blower, or was the glass blowing operation performed in a neighbour's house where gas *was* laid on? Again we find, "I studied chemistry off and on for 10 or 12 years"—and this, too, without being able to read even the labels on bottles of re-agents, &c., to say nothing of not being able to read about the properties of elements, compounds, and the like. Learning chemistry under such circumstances must indeed have been uphill work. Yet again Goebel states he had "made a magnetic [magneto-electric] machine for generating current." It seems rather curious that he should be familiar with these machines and yet not have heard, in conversation with others, of the success of the machines of Gramme, Siemens, Brush, &c. His lamp would surely be sufficient to make him keenly alive to developments in producing electricity since, as he says, this was all that was necessary to make his lamp commercially successful. He was at least acquainted with the fact that a battery was not the only means of generating electricity. Another suspicious circumstance, testified to in Mr. Wm. C. Dreyer's affidavit, is that Goebel had applied for patents for his mercury pump, and a spiral carbon-holder for incandescent lamps (whatever that may be), but not for the lamp. The point is one which can be demonstrated beyond all possible dispute by a search amongst the records of the Patent Office. It is unreasonable to suppose that a man who would think it worth while to patent such devices and apparatus should not do the same with a wholly new appliance over which, he maintains, he devoted so much attention, labour, and expense. Another and still more important piece of testimony is the following episode taken from J. C. Goebel's affidavit. "Recalled the shooting of one Kay by another, Sickles, which occurred on February 27th, 1859, in his father's shop under the light of one of his father's incandescent lamps which stood on the show case at the time. The occurrence was also illustrated at the time in an illustrated paper of the day, which also pictured the lamps as he now recalled them. The lamps presented, exhibits 1, 2 and 3, he identified as exactly like his father's lamps as made at the time." The illustrated paper referred to can no doubt be produced and examined, and it is a satisfaction to know that it cannot lie, as people have power to do.

It is a somewhat remarkable circumstance that Messrs. F. L. Pope and C. R. Cross, who were formerly experts for the Bell Telephone Company in the matter of the unsuccessful claimant Drawbaugh, should now be the advocates of the claimant Goebel.

WHO DISCOVERED THE RATIO OF TRANSFORMERS?

BY RANKIN KENNEDY.

IN looking over the first volume of the *Practical Mechanic's Journal*, published in Glasgow in March, 1849, I was astonished to notice in a paper read before the Royal Scottish Society of Arts by Grant. S. Dalrymple, Esq., civil engineer, of Edinburgh, a distinct statement of the ratio of the transformer. It has been imagined that the ratio of the transformer was discovered some time during the past 10 years; but here it is given clearly in a paper 44 years ago.

Quoting from the paper: "The author considered that by a proper attention to the subject of what is called induced electricity, as in the case of primary and secondary coils . . . very important results would be arrived at. It would be interesting if formulæ could be laid down for determining the intensity of the current generated in the secondary wire, supposing it to be a certain number of times the length of the primary wire.

"Thus let a = length of primary wire, and let the secondary be $. n .$ times the length of the primary, or = $. n . a .$ Let f be the force of the current in the primary coil; let $. x .$ be the force which is to be determined in the secondary coil; then will $x = \frac{n\ a\ f}{a} = n\ f$ be the formulæ."

Small apparatus were exhibited, showing how this held good in some cases.

The author also suggested that galvanic electricity would, ere long, be employed for lighting our streets in place of gas. A suggestion which has not yet been adopted in Edinburgh, where this paper was read about half a century ago.

OBITUARY.

[FROM OUR SPECIAL CORRESPONDENT.]

I REGRET to have to announce the death of Mr. E. C. Cracknell, late Superintendent of Telegraphs in New South Wales, and Lieutenant-Colonel commanding the Partially-paid Submarine Mining Corps of the same colony. Mr. Cracknell came out to the colonies in November, 1855, going first to Adelaide, where he acted as Assistant Superintendent of Telegraphs, under Mr. Charles Todd, C.M.G., the present head of the South Australian Post and Telegraph Departments. Mr. Cracknell retained this position till towards the end of 1857, when he left Adelaide for Sydney, and on January 1st, 1858, he took up the duties of assistant-superintendent of telegraphs in the colony of New South Wales. At the time Mr. Cracknell joined the telegraph service here there were only two lines in existence; one connecting Sydney to Parramatta, a distance of about 12 miles, and the other connecting Sydney to South Head, for signalling the approach of inward-bound ships. At the present time there are over 600 telegraph stations open and 24,000 miles of line constructed and working, almost the whole of which

work has been inaugurated and carried out by Mr. Cracknell, who was appointed superintendent in 1861, and has held the position ever since.

In addition to the telegraph service, Mr. Cracknell was closely identified with local military matters. He was one of the first to urge the wisdom of providing for the defence of the harbours of the colony, and evinced an untiring interest in torpedo and submarine mining warfare, and to him belongs the honour of laying and firing the first torpedo in the colony, at South Head, in 1871. In April, 1874, he received a commission as lieutenant in what was known as the Torpedo Corps, and which was attached to the Naval Brigade. In 1877, the Torpedo Corps was transferred from the naval to the military forces, and was styled the Submarine Mining Corps. With the change in organisation, Mr. Cracknell received promotion to the rank of major, and on April 6th, 1886, he was gazetted Lieutenant-Colonel commanding, which position he held up to the time of his death. The illness, angina pectoris, which proved fatal, can be traced back to an all-day parade of the Submarine Miners, at which Mr. Cracknell, in carrying out his duties as commanding officer, undoubtedly overstrained himself.

Mr. Cracknell was, or had been at some time, a member of numerous scientific bodies, amongst them being the Institution of Civil Engineers, the Institution of Electrical Engineers, of which he was local honorary secretary and treasurer, the Society of Arts, Chemical Society, &c., of England, and the Royal Society, Engineering Society, and Electric Club of New South Wales. In consequence of Mr. Cracknell's position as Lieutenant-Colonel commanding the Submarine Miners, the body was interred with full military honours. The coffin was carried from the house to the gun-carriage by six subalterns of the deceased officer's own corps to the gun-carriage which conveyed the body to the place of interment, Waverley cemetery. The order of the procession, which was fully a mile and a-half long, was as follows: A small detachment of mounted artillery, a firing party, consisting of 200 men of the permanent Artillery and 100 of the Submarine Mining Corps, the gun-carriage bearing the coffin, the entire carriage being covered with wreaths, six colonels as pall-bearers, a carriage filled to overflowing with wreaths, the chief mourners, a carriage containing the Postmaster-General, the Minister for Mines and the Minister for Education, representing the Government, about 400 of the officers of the telegraph department, from Sydney and all parts of the country, members of the Electric Club, of which the deceased was president, detachments representing the various military bodies, and finally a number of vehicles containing civilian friends.

An enormous number of wreaths were sent, amongst them being one inscribed "A tribute of sincere regard and deepest sympathy from the officers of the Eastern Extension Cable Company in London and Australia." Floral tributes were also sent by the Postmaster-General, the various staff officers, the officers of the New South Wales Artillery, the Volunteer Artillery, the Engineering Corps, and the Submarine Miners, the non-commissioned officers and men of the Submarine Miners, the Electric Club, the Telegraph Operators' Society, the principal officers of the Telegraph Department, the telephone branch, accountants branch, mechanicians branch, and electric light branch of the Telegraph Department, the electrical engineering branch of the Railway Department, and from the Post and Telegraph Staffs of offices all over the colony, east, west, north, and south, besides a large number from private friends. It is generally said to be the largest and most impressive funeral ever seen in Sydney, and enormous crowds lined the way and filled the cemetery, and it is admitted on all hands that the public service has lost an officer who cannot be replaced. Amongst Mr. Cracknell's more recent works may be mentioned the drawing up, in conjunction with Prof. Threlfall, of a report on the proposed lighting of the city of Sydney.

North Bierley Electric Lighting.—The fact that a certain portion of North Bierley district was not lighted by public lamps has given rise to many very serious complaints. The Local Board, however, have recently lighted a part of the lane complained of, by electricity. Incandescent lamps of 16 C.P. are used. Messrs. Ullathorne and Edmondson, electrical engineers of Bradford, erected the lamps and wires.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

AN ordinary general meeting of this Institution was held on Thursday, February 23rd, Mr. W. H. PREECE, F.R.S., President, in the chair. The general business having been transacted, a paper was read by Mr. W. M. MORDEY "ON TESTING AND WORKING ALTERNATORS."

In connection with the testing of large dynamos, the provision of the necessary power is often a very serious matter; and the driving plant for this purpose is a heavy item in the equipment of a dynamo factory, especially as, in order to get the full output from machines of sizes that are now often made, much larger boilers and engines are required than for the works where the machines are made.

Very little has been written about the actual testing of alternators, and, so far as I am aware, they have always been tested in the manner commonly followed with direct current dynamos—that is to say, they have been run on circuits of lamps, or on wire or other resistances, either directly or through transformers. Where it is desired to test the prime motor as well as the alternator there is no need to do more than this; but when engine and boiler powerful enough are not available, or when it is desired to carry out long runs at the least cost in plant and fuel, other methods have to be sought for, and we naturally turn for assistance in this matter to the method of circulating power first devised and described by Dr. Hopkinson.

Dr. Hopkinson's method may be applied to two alternators coupled mechanically and driven as in his original test of direct current dynamos. It is, however, much more convenient to be able to run machines singly. The necessary conditions for this are readily realised in an alternator, especially if the armature is stationary; and, in this way, I wish to show, in the first place, that it is possible to run an alternator under all the essential conditions of full load with only a small absorption of power. This may be done simply by dividing the armature circuit into two portions and so connecting them together that one has a higher E.M.F. than the other, the stronger portion acting as a generator, absorbing power, and driving the current through the weaker portion, which acts as a motor, returning the power to the generator portion, less the losses.

The two portions of the armature may be made of unequal E.M.F. by dividing the armature into two unequal portions, as shown by fig. 1, which represents the armature of an alternator. The coils are

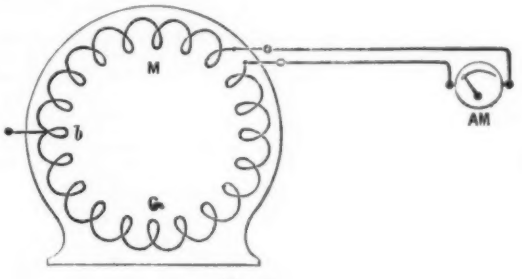


FIG. 1.

joined up so that the portion M is opposed to the portion G. By making G greater than M, and by running with the field magnet excited, any required current may be made to circulate round the whole armature. This current is measured by an ammeter put in at any part of the circuit. The volts of each coil, or the volts across the junction of the portions M and G, may be taken in the usual way. When the full current is circulating, with the full field and full speed, the machine will be working at full load, so far as mechanical strains and electrical losses are concerned, and the power to drive it will be merely that required to make up for the mechanical and electrical losses. The efficiency is then easily found.

TEST OF AN "A 20" 250-KILOWATT ALTERNATOR.

The machine was driven by an engine from which indicator diagrams were obtained. It was found that the I.K.W. was three kilowatts more when excited than when not excited. This is lost in eddies. The armature was then joined up in two portions, as in fig. 1, and a current of 60·25 ampères circulated, with a P.D. of 1,656 volts across the junction of the two. This was equivalent, so far as internal losses were concerned, to an output of $1{,}656 \times 60{\cdot}25 \times 2 = 199{\cdot}5$ kilowatts. The power absorbed was 6·37 kilowatts more than when not excited. As the power wasted in eddies was three kilowatts, the loss due to the circulation of the current is $6{\cdot}37 - 3 = 3{\cdot}37$ kilowatts. To check this, we may examine the resistance. The armature has a resistance of 0·23 ω when the two sides are parallel, but as all the coils were in series in this test, the resistance was $0{\cdot}23 \times 4 = 0{\cdot}92\ \omega$. We will call this 1 ω to allow for a slight increase due to heating. The C^2R loss thus would be $60{\cdot}25^2 = 3{\cdot}63$ kilowatts. This is a very fair confirmation. As a matter of opinion, I have very little doubt that the eddies are less under load than on open circuit.

To ascertain the efficiency we have to add the excitation and the friction. The excitation was 1·365 kilowatts. The friction is the only quantity not determined, as it could only be obtained as part of the total friction, including engines, ropes, and alternator. But I have put down three kilowatts for alternator friction, and this will no doubt be considered fair, as there was scarcely any perceptible warming of the bearings. A good deal of air is moved by the magnet, but we know that in this very little power is spent. The losses are:

	H.P.	K.W.
Friction	4	3
Excitation	1·83	1·365
C^2 R and eddies... ...	8·54	6·37
Total	14·37	10·735
Output	267·47	199·5

Commercial efficiency—

$$\frac{199\cdot5}{199\cdot5 + 10\cdot735} = 0\cdot9489.$$

The "electrical efficiency"—

$$= \frac{3\cdot63 + 1\cdot365}{199\cdot5 + 3\cdot63 + 1\cdot365} = 0\cdot9675.$$

The power required to drive the alternator has to be supplied and measured mechanically. This may be done by a transmission dynamometer, or by indicator diagrams of the engine. Neither of these methods is quite satisfactory, or quite direct enough. A direct electrical measurement of the whole of the losses is the only one that can be considered fully satisfactory. One way in which this may be obtained is shown by fig. 2.

This arrangement reduces the power necessary to test a machine at full load to rather more than half the usual amount.

An alternator armature, A¹, is divided into two portions, M and G. The machine is run up to synchronism with another alternator, A, which may be of about half the capacity of the machine to be tested. The part, M, of the machine, A′, is then run as a motor, while the part, G, is used as a generator doing work on an external circuit, R. The belt is thrown off. The machine acts, in short, exactly in the manner of an ordinary direct-current dynamotor. The input and output are measured by wattmeters or otherwise across the respective terminals.

The total losses = input + excitation − output.

$$\text{The efficiency as a dynamotor} = \frac{\text{output}}{\text{input} + \text{excitation}}.$$

When the generator portion is working at half the normal output of the alternator, the motor half will be working at a little more than its full load, and the internal losses will be the same as if the machine were working at full output (the only difference being that the friction losses are put in electrically instead of mechanically). The full load efficiency under these circumstances

$$= \frac{\text{output} \times 2}{\text{input} + \text{output} + \text{excitation}}.$$

It will be noticed that this involves the assumption that the efficiency of the machine as a motor is the same as when used as a generator—an assumption that is fair.

Some particulars of a test of an "A 10" 50-kilowatt alternator arranged in the manner shown in fig. 2 are given below.

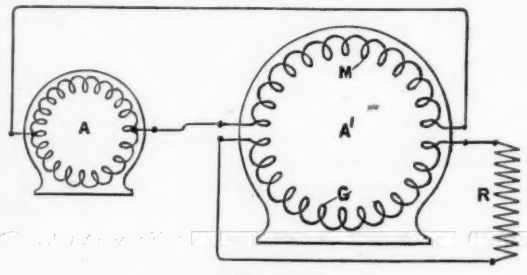


FIG. 2.

The machine was separately excited and driven up to synchronism with a 25-kilowatt alternator. One half, M, of the armature was then run as a motor, and readings were taken of the current, volts, and watts—the latter by a modified Siemens electro-dynamometer, used as described by Dr. Fleming, and having an added resistance of 1,000 ohms of non-inductive platinoid wire capable of easily carrying a current of 2 ampères.

The generator portion, G, was run on a circuit of straight platinoid wire, and the output was measured in ampères and volts. The circuit was one that had been in use for a long time, and had been carefully tested and found to be non-inductive and without sensible capacity. The test of this circuit, as of others in which a similar quality was desired, consisted simply in ascertaining that a given P.D., whether A.C. or D.C., gave similar current readings on a Siemens dynamometer.

True watts are therefore correctly given by $c' \times v'$.

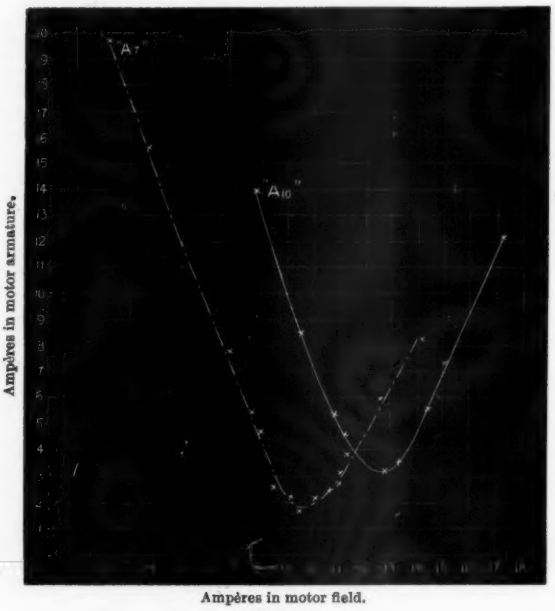
The field was separately excited, and the current and volts measured. Speed was constant at 600 revolutions = 100 ~.

Another way, arising naturally out of fig. 2, is to circulate the power given by the portion, G, back to the circuit of A to M instead of wasting it on the resistance, R. This may be done by putting one winding of a transformer of suitable size in place of the resistance, R, and a second winding of the transformer in the circuit between A and M. In order that this should succeed, it is necessary that the transformer should be capable of allowing a sufficient current to pass through one winding alone to run the machine as a motor lightly loaded. Then the portion, M, will be traversed by a current larger than that produced by G, otherwise the machine would not run as a motor.

LOAD-FACTOR OF ~ MOTORS.

The "load-factor," or "plant efficiency," of alternate-current motors, whether synchronous or not, is a subject of great importance, on account of its bearing on the economics of power-transmission by alternate currents. Although at the moment the load-factor of motors is not as pressing a matter as the load-factor of transformers (which has received Dr. Fleming's recent attention), it is desirable to find whether for alternate-current motors we have to use cables and machinery capable of carrying a large idle current, or whether we can treat power transmission projects, so far as these matters are concerned, in the simple manner that is possible with alternate-current transmission with good closed magnetic circuit transformers. I am able to say that, so far as my own observations go, working with one class of alternators, the load-factor of these machines when used as motors, under fair loads, is very high, if they are used under conditions that are easily obtained.

Fig. 3 illustrates the way in which the load-factor varies with the excitation. The two V-shaped curves show the current that was



Ampères in motor field.

FIG. 3.

taken respectively by an "A 7" 25-kilowatt alternator and by an "A 10" 50-kilowatt alternator, running as motors, without load, when the excitation was varied. They were driven by another alternator, and a P.D. of 2,000 volts was maintained across the terminals. Speed constant at 100 ~.

It will be observed that in each case there is an excitation that reduces the armature current to a minimum, and, therefore, gives a maximum load-factor and maximum efficiency. If the excitation is varied on either side of that value, the armature current rapidly increases.

In order to find whether the same kind of effect takes place when the motor is loaded, one of the motors was made to drive another alternator, the load on which was varied. It was found, as was to be expected, that with various loads, and, of course, at constant speed, there was for each load an excitation that corresponded with a minimum armature current; that the armature current rose on varying the excitation either up or down; and that the excitation that gave the lowest armature current (or the highest efficiency and

TEST OF "A 10" ALTERNATOR.

Motor portion.					Generator portion.			Excitation.				
c.	v.	Wattmeter, w.	c × v.	Load-factor $\frac{w}{c \times v}$	c′	v′	c′ × v′	Watts, w.	w + w.	Dynamotor efficiency, $\frac{c' \times v'}{w + w}$	Losses. $w + w - (c' \times v')$	Commercial efficiency, $\frac{2\,c' \times v'}{w + (c' \times v') + w}$
8·023	2,000	15,344	16,046	0·95	6·9	1,960	13,584	420	15,764	0·868	2,180	0·9257
9·278	2,000	17,628	18,556	0·95	8·1	1,950	15,855	427	18,055	0·878	2,200	0·935
10·5	2,000	19,950	21,000	0·95	9·3	1,940	18,102	427	20,380	0·89	2,278	0·941
10·22	2,000	19,418	20,440	0·95	8·6	2,040	17,604	465·9	19,884	0·885	2,280	0·938

highest load-factor) was approximately the same for all loads, with the same impressed P.D.

This is what one would expect. With a weak field a large armature current is required to give the necessary torque; while with a strong field the E.M.F. of the motor is higher than that of the generator; the driving current, therefore, is large for a given torque, as it cannot get in advantageously.

It will be remembered that Dr. Hopkinson predicted years ago that an alternator would run as a motor under the condition of the motor having a higher E.M.F. than the generator.*

From these curves we see that the load-factor may vary enormously, but there is no difficulty in making it a minimum and the efficiency a maximum, by always working at the excitation that gives the lowest reading of current. It will be seen from the table of results given above that the load-factor is high. It appears to fall away at no load to a much lower value, as will be seen from an examination of the two curves. This, however, is of no practical moment, as the machines do not take much to drive them under light load conditions; and although I have not made determinations at intermediate points, it appears that, as was shown by Dr. Fleming to be the case with closed-circuit transformers, the load-factor approached unity as soon as load was put on.

It is satisfactory to find that, in this respect, these two classes of alternate-current apparatus have similar qualities.

The present opportunity may be taken to allude to a device which I have used for some time in connection with the working of alternators, and which we apply to all the larger machines. In alternator armatures there are advantages in having the coils arranged in two or more parallel portions, instead of all in series. The insulation of the terminal portions of the winding is easier, and, except in small machines, the conductors are more manageable. But in practice we have found that the parallel arrangement has one drawback. Unless the coils are equally and simultaneously acted on all round, the voltage of the two portions will not be equal, and a circulation of current will take place within the armature. The machine will, in fact, act to some extent as in the dynamoter method described, and a loss of power will result. This has probably been overlooked in machines having revolving armatures, as with such armatures it is not easy to observe the effect. It is difficult to avoid this circular current by ordinary means. If the pole faces are exactly alike in size and position, and the polar gap is the same all round, and the armature coils are identical in winding and in relative angular position, the inequality will not exist. But these are conditions that can only be certainly obtained at a considerable expense. With cast magnets the poles vary a little. The armature coils are adjusted radially, and it would be troublesome and expensive to place them so as to comply with the conditions mentioned.

By a simple application of a known property of transformers this difficulty is avoided.

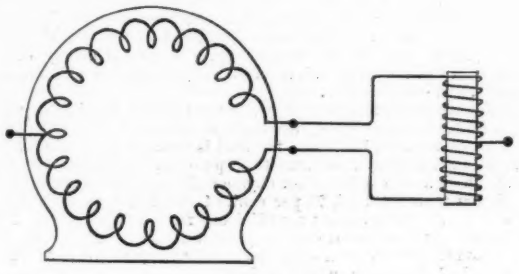


FIG. 4.

This is shown in fig. 4. A pair of similar coils is arranged in the manner of a transformer, one coil being placed in each half of the armature circuit. The connections are such that with equal currents from the two portions of the armature there is no magnetism induced, the two windings neutralising one another. But any tendency of one portion of the armature to give a larger current than the other portion is resisted by the "equaliser" (as I term this apparatus), which then acts as a transformer opposing an E.M.F. in the circuit which has an excess, and adding a corresponding E.M.F. to the circuit of lower voltage. Thus the two portions of the armature contribute equally to the external circuit, while the circular current is prevented, whether on open circuit or under load. The equaliser is quite a small affair. As an example of its efficacy, I may mention that in one case the two sides of a 250-kilowatt 2,000-volt alternator were made so unequal that a current of 16 ampères circulated. The addition of a small "equaliser" reduced this circular current to half an ampère.

PARALLEL WORKING OF ALTERNATORS.

In working alternators in parallel the precautions that should be observed will be best understood by a consideration of the following:—

Consider the case of two alternators.

Assume that one alternator, A, is running and doing work driven by its engine, E, and that it is required to start the second alternator, A_1, with its engine, E_1.

Start the engine E_1 and excite the alternator A_1.

If the fields of the alternators are excited in parallel from the same exciting source—as is preferred, and as we arrange whenever possible—there is no necessity for any adjustment of the individual excitation (except for differences of temperature). It is merely necessary to connect the field to the exciter. It will then receive the proper field current. Let the double pole main switch of A_1 be open. The synchroniser is then to be switched on, and the speed of the engine E_1 adjusted till the synchroniser lamp is steady, showing that the alternators A and A_1 are running at the same speed. It will not be found difficult to so adjust the engine E_1 that the synchroniser lamp shall remain steady for several seconds at a time. For greater accuracy a voltmeter may be used instead of or in addition to the synchroniser lamp. When the synchroniser lamp (or voltmeter) is at its highest, the double pole main switch of A_1 should be closed, so connecting the alternators in parallel. It will be perceived that at this time the engine, E_1, is only supplied with steam sufficient to drive the alternator, A_1 (without load), at the required speed. The alternators when put in parallel will therefore merely keep in step, A_1 doing no work on the external circuit and receiving no power from that circuit. This will be shown by its ammeter, which will show that no current, or only a very small current, passes between the machines.

As the supply of steam is increased, the ammeter of A_1 will show an increased reading, while that of A will show a decreased reading, until (in the case of alternators of the same size) the two instruments show that the load is equally divided between the machines. When this condition is attained no further regulation of engines is required, any increase or decrease of load dividing equally between them.

The control of E.M.F. is effected by regulating the exciter, and not by means of resistances in the field circuits of the alternators. As the fields are all wound to excite from the same mains, there is no need for an individual regulation of the fields, except, perhaps, a slight adjustment to compensate for difference of temperature between machines that are being started cold to work with others that have become warm by long running. The field ammeter should be observed in order to give each machine the same excitation.

To stop one alternator when two or more are running, the load should not be switched off suddenly, but steam should be gradually reduced by the governor or stop-valve of the engine until the alternator is doing no work, as shown by its ammeter. Then the switch between the alternator and mains should be opened and the engine stopped.

If the steam is gradually reduced in this way, the load will be transferred to the remaining engines and alternators before the machine is switched off, and no racing of the engine can occur.

Steam should be turned off till the ammeter needle goes back to zero, showing, that the alternator is not doing any work. If steam is continued to be turned off beyond this point, the alternator will then *take* current (to drive it as a motor and to enable it to drive its engine), and the ammeter needle will, after going back to zero, show a deflection representing this received current.

It may perhaps be pointed out that artificial loads need not be used in putting alternators in parallel. This is sometimes done, but it can only be necessary where the characteristics of the machines show great variations between no load and full load.

DISCUSSION.

Mr. MILLER: Towards the end of last year Messrs. Fleming, Nicholson, and myself carried out a series of experiments on the 12 H.P. Ferranti alternator at the City and Guilds Central Institution, and the results confirmed the idea that this method of testing the power and efficiency of an alternator with rotating armature could be practically employed. The method we employed was briefly as follows:—The field magnet coils of the Ferranti dynamo were connected in parallel so that the current passed round the upper and lower coils in opposite directions. The Ferranti alternator was driven by a separately excited direct current motor, the shafts of the two machines being joined by a spring. Throughout the whole experiment the currents in the two halves of the Ferranti field were so adjusted by means of a variable resistance in one of them as to produce sufficient E.M.F. in the armature (which was short-circuited by an alternate current ammeter) to send 20 ampères through this armature. The alternator was now run at different measured speeds, and the electrical power required to drive the direct current motor measured; then subtracting the power wasted in heating the armatures of the Ferranti and the direct current motor, we obtained the power expended on eddy currents and in overcoming the friction of bearings of the dynamo and motor. The power wasted in the motor was then separately determined by ascertaining the power required to drive the motor at the same speed when its spindle had been uncoupled from that of the alternator. So that we have finally the power wasted in the Ferranti alternator, in eddy currents, mechanical and friction. Having obtained this it was then quite easy to calculate the efficiency at different speeds by aid of the characteristic curves of the Ferranti alternator.

Prof. AYRTON: It will be seen that that method of testing an alternator with a rotating armature by dividing the field into two parts is equally applicable to direct current multipolar machines. Direct current dynamos are being made on the Continent now with many poles, not merely the four or six poles we use in England. In fact, the machines on the Continent are not so very unlike an alternator, only the currents are commutated. Such a machine then can be tested at once by simply taking off the pole and joining it electrically to the other half of the field. It is not necessary, as Mr. Mordey suggested, to have two commutators on the armature; it may be an ordinary armature with a single commutator, take one off, join it the other way to the other half of the field, turn the whole machine by means of a very small direct current machine, and we have the power and efficiency of the direct current machine. Of course there is one point about all these methods, one objection, which does not apply to the original method suggested by Dr. Hopkinson some years

* *Journal*, Vol. xiii., p. 505, November, 1884.

ago. In Dr. Hopkinson's method there were two distinct direct current machines with their shafts coupled together, one working as a motor and one as a dynamo, and the H.P. that each machine was developing was actually transmitted through the shaft. Now, it is to be observed in the interesting method which Mr. Mordey has described, and the extension of it described by Mr. Miller, that the stress on the shaft is not tested at all, and it might be that the shaft would be weak or the bearings might heat when the shaft was required to constitute 100 H.P., which would not come out at all in the method of testing described. There is this to be said in favour of the method, it might be possible at some time or other to drive the machine and see that you could get something like 100 H.P. without the working efficiency test, and still leave Mr. Mordey's method valuable for efficiency testing. It is quite clear that if you have not an engine giving more than 10 H.P. you cannot in any way transmit 100 H.P. through the shaft. It might be objected that the method I have spoken of, using direct current dynamos on multipolar fields, coupling one-half the wrong half to the other half, you get a distortion of the field, and the result would not truly represent what would happen if there were no absorption. That is true to some extent, and it is also true of Mr. Mordey's method; in one coil the current is in one direction and in the other in the opposite direction. The method he suggested with the motor-dynamo would have the same sort of objection. However, I do not think that with the multipolar field that is a very serious matter. If you only had two poles no doubt it would be a serious matter. You would distort the whole of the lines of force. But if there are many poles in the circle round the machine, whether alternating or a direct current machine, not much harm is done to the test by having one-half of the set of magnets magnetised the other way.

Prof. S. P. Thompson: There are one or two little points of criticism which I hope Mr. Mordey will not object to my raising here. When he divides the armature into two parts, and runs the machines thus, that surely is not quite exactly the equivalent of running a generator and a motor, because the generator and the motor are not rigidly coupled together so that the E.M.Fs. are necessarily in entire opposition of phase, and if there is any self-induction in the circuit in between, if there is any capacity to improve on the circuit in between, then there will be a difference of phase between the two machines, that is to say, they will not be exactly in opposition of phase as they are in the motor coils and the generator coils in the divided machines. This may be entirely unimportant; at any rate it is unimportant when one works with low voltages and short mains, though with long mains and high voltages it may make an important difference. Again, Mr. Mordey makes the assumption that the efficiency of the machine as a motor is the same as when used as a generator, an assumption which he shows is fair. Well, again that depends to some extent on the conditions of the circuit. The circuit is one that has self-induction in it or in which capacity effects are important, then it is a question whether the assumption is fair, because the phase ratio of the capacity, the phase relation of the current, may be different, and the current may be acting to excite its own field magnets. In that case, on the other hand, the current in the armature of the generator would be demagnetising its own field magnets. The effects might not be important, still they exist.

The discussion was then adjourned.

ELECTRICAL RAILWAYS.*

By Dr. EDWARD HOPKINSON.

One of the most striking of the many new departures in the practical application of electrical science, which made the Paris Exhibition of 1881 memorable, was a short tramway laid down under the direction of the late Sir William Siemens from the Palais de l'Industrie to the Palais de la Concorde, upon which a tramcar worked by an electric motor plied up and down with great regularity and success during the period of the Exhibition. Yet few of those who saw in this experiment the possibilities of a great future for a new mode of traction would have ventured to predict that within 10 years' time, in the United States alone, over 5,000 electric cars would be in operation, travelling 50,000,000 miles annually, and carrying 250,000,000 passengers, or that electric traction would have solved the problem of better communication in London and other large cities. Two years before the Exhibition in Paris, the late Dr. Werner Siemens had exhibited at the Berlin Exhibition in 1879 an experimental electric tramway on a much smaller scale, and this firm had put down, in 1881, the first permanent electric railway in the short length of line at Lichterfelde, near Berlin, which, I believe, is still at work. In the same year Dr. William Siemens undertook to work the tramway, then projected, between Portrush and Bushmills, in the North of Ireland, over six miles in length, by electric power, making use of the water-power of the Bush river for the purpose, an undertaking which I had the advantage of carrying out under his direction. It is no part of my object to-night to follow further the history of electric traction, which is so recent that it is familiar to all; but, in alluding to these initial stages of its development, I have desired to recall that it was to the foresight and energy of Drs. Werner and William Siemens, and their skill in applying scientific knowledge to the uses of daily life, which gave the first impulse to the development of the new electric power.

* Read before the Royal Institution.

The problem of electric traction may be naturally considered under three heads:—

1. The production of the electric power.
2. Its distribution along the line.
3. The reconversion of electrical into mechanical power, in the car motor or locomotive.

The first of these, here in England, at any rate, is dependent upon the economical production of steam power, although there are essential points of difference between the conditions under which steam power is required for electric traction purposes, and for electric lighting. But in Scotland and Ireland, and in many countries abroad, there is abundant water power, now only very partially utilised. The Portrush line is worked in part by water, and in part by steam power; but in the Bessbrook and Newry tramway (of which there is a working model on the table), water power is exclusively used.

A few experiments will show that the demand for power on the generating plant is greatest at the moment of starting the car or train; when in addition to the power required to overcome the frictional resistances, power is also required to accelerate the velocity. Thus, if instead of a single car, there are a number of trains moving on the one system, and it so happens that several are starting together, the demand made upon the generating plant may, at one moment, be three or four times as great as that made a few seconds after. This is shown in the diagrams which exhibit the variation of current supplied by the generators on the City and South London Railway, with eight trains running together, the readings being taken every 10 seconds, the maxima rise as high as double the mean; thus the generating plant must be capable of instantly responding to a demand, double or even treble the average demand upon it.

In electric lighting it is true there is not less variation between the maximum demand and the mean taken during the ordinary hours of lighting; but it is only in the event of sudden fog that the probable demand cannot be accurately gauged beforehand, and provided for by throwing more generators into action. Thus in a lighting station each generator may be kept working approximately at its full load, and therefore under conditions of maximum economy, whereas, in a traction station, the whole plant must be kept ready to instantaneously respond to the maximum demands which may be made upon it; and must therefore necessarily work with a low load factor, and consequently with diminished economy. So important is the influence on cost of production of the possible demand in relation to average demand, that the corporation of Manchester in their electric station, which is now nearing completion, have decided, upon the advice of their engineer, to annually charge a customer £3 per quarter for each unit per hour of maximum supply which he may require, in addition to 2d. per unit for each unit actually consumed, *i.e.*, for being ready to supply him with a certain amount of electrical power if required to do so, they charge an additional sum equivalent to the charge for its actual consumption for 1,440 hours.

In one respect water power has an economic advantage over steam power, because although steam engine and turbine alike work with greatly reduced efficiency at reduced loads, when the turbine gates are partially closed and the water restrained in the reservoir, it is not subject to loss of potential energy, whereas the energy of the steam held back by the valves of the engine suffers loss through radiation and condensation.

At Bessbrook the turbine and generator dynamo combined yields 60 per cent. of the energy of the water as electrical energy available for work on the line, but when the load is reduced to a third of the full load the efficiency is reduced to 33 per cent. So on the City and South London line a generator engine and dynamo will yield, when working at their full load, 78 per cent. of the I.H.P. as useful electrical power, but at half-load the efficiency falls to 65 per cent. Notwithstanding these conditions, the generator station of the City and South London line is producing electrical energy at a cost of 1·56d. per Board of Trade unit, which is less than the annual average cost of production of any electric station in England, with the single exception of Bradford, which has the advantage both of cheap coal and cheap labour. In output it is the largest of any electric generating station in England, the total electric energy delivered in 1892 being 1,250,000 Board of Trade units, the second on the list being the St. James and Pall Mall with 1,186,826.

Let us pass, now, to the consideration of the distribution of the electric power along the line. I have equipped the three model tracks before you with three different kinds of conductors. In two of them the rails of the permanent way, which are necessarily uninsulated, are made use of for the return current. This plan with, I believe, the almost single exception of the Buda Pesth tramway, has been universally adopted, with the object of saving the cost of a return conductor; but it is doubtful whether such an arrangement can be considered final, for it must necessarily create differences of potential in the earth, which already, in some instances, have had disturbing effects upon our observatories, or upon our telegraph and telephone systems. It appears to be probable in the more or less distant future that the use of the earth for the passage of large current will be guarded by legislation; and that it will be reserved for the more delicate and widely extended operations of telegraphy and telephony. These disturbances may of course be easily avoided by the use of an insulated conductor for the return circuit. In the case of conductors which are in such a position that contact may be made from them to the ground through the body of a horse or some other animal coming into contact with them, there is another strong argument for an insulated return, as many animals, and notably horses, are far more sensitive to electric shock than man. It is not, perhaps, well known, but still a fact, that a shock of 250 volts is quite sufficient to kill a horse almost instantaneously.

The first model has a single overhead conductor with return by the rails, but in place of a single fishing rod collector or trolley to take the current from the overhead wire there are fixed on the car two

rigid bars, one at each end, which slide along the under surface of the wire and make a rubbing contact against it. This system, devised by Dr. Jno. Hopkinson, has the advantage that there is less difficulty in maintaining contact on uneven roads or on curves, and that the catenarian of the suspended wire may be hung with greater dip and therefore with less tension. Again, the double contact obviates the frequent breaks and consequent sparking of a single trolley system. The second model shows the system, adopted on the City and South London line and more recently followed on the Liverpool Overhead line, of a conductor of channel steel, upon which collectors, fixed to the locomotives, make a sliding contact. The third track shows an overhead system like the first, but with an insulated return in place of return by the rails.

The characteristic features of an electric motor is that it delivers us the mechanical power we require directly in the form of a couple about an axis instead of in the form of a rectilinear force, as is the case with steam, gas or air engines, which must be reduced to a rotary form by connecting rod and crank, thus it is possible to sweep away all intermediate gear and to arrive at once at the simplest of all forms of a traction motor, consisting of but one pair of wheels fixed on a single axis with the armature constructed directly upon it, with its magnets suspended from it and maintained in their position against the magnetic forces acting upon them by their weight. Such a locomotive is shown in the third model before you. So far as I am aware, a locomotive of such simplicity as this has never been constructed for practical work, but on the City and South London line the armatures of the motors are placed directly on the axles and the magnets suspended partly from the axles and partly from the frame.

The second model is an exact reproduction of the locomotives on the City and South London line, but with a different arrangement of motors. Here both armatures are included in the same magnetic circuit, and both magnets and armatures carried on the frame of the locomotive and not on the axles, and are geared to the axles by diagonal connecting rods, the axle boxes being inclined, so that their rise and fall in the horn blocks is at right angles to the connecting rods. This design, which is due to the late Mr. Lange, of Messrs. Beyer, Peacock and Company, allows of the motor armature being placed on the floor level of the locomotive, and so more easily accessible.

This model will serve to show some of the characteristic features, as well as some of the characteristic defects, of an electric motor as such. But in order to show these clearly, I may refer for a moment to the general theory of a motor. It is easily shown that in a series-wound motor the couple or turning moment on the axle is a function of the current only, and independent of the speed and electromotive force. Again, it follows from Ohm's law that the current passing through the motor, multiplied by the resistance of the magnet and armature coils, is equal to the difference between the electromotive force at the terminals of the motor and the electromotive force which would be generated by the motor if it were working at the same speed as a generator of electricity, *i.e.* to say, the difference between the electromotive force at the terminals, and what is called the "back" or "counter" electromotive force of the motor. Hence if the terminals of the motor be coupled direct to the line at the moment of starting, when the motor is still at rest, the current will be very great, and its power entirely absorbed in the coils of the armature and magnets, but the turning moment will then be a maximum. The motor then begins to move, part of the power being spent in overcoming frictional resistances, and part in accelerating the train. A back electromotive force is then set up, increasing as the speed increases, and causing the current to diminish until, finally, a position of equilibrium is established, when the speed is such that the back electromotive force, together with the loss of potential in the coils of the motor, is equal to the potential of the line. But in practice the mechanical strength of the motor, and the carrying power of its coils, as well as the limited current available from the generators, makes it necessary to introduce resistances in circuit with the motor to throttle the current and to reduce it within proper limits. It is to this point I desire to draw attention, that in traction work, when starting, the motor resistances must be introduced, which, with the resistance of the motor itself, at the moment of starting, absorb the whole power of the current, reducing the efficiency of the motor to nil, and continue to absorb a large percentage of the power, until the condition of equilibrium is established. This is the great defect in electric motors for traction work, and its importance can be shown very clearly by reference to the work done on the City and South London line. There the motors, when working with their normal current, have an efficiency of 90 per cent., but the actual all-round efficiency of the locomotives as a whole is 70 per cent. only, so that the loss in starting is equal to 20 per cent. of the whole power. Of course in some respects the City and South London line is exceptional, in that a start is made every two or three minutes. Various devices have been suggested with a view to diminish this waste of power in starting an electric motor, but none entirely meet the case. Thus if the locomotive or car has two motors, these can be coupled in series at the start, and subsequently thrown into parallel, thereby doubling the tractive force with a given current, or for the same tractive force reducing the loss of power by three-fourths. When through the increase of speed of the motor the back electromotive force balances the electromotive force of the line, the speed can be increased by diminishing the magnetic field by reducing the effective coils on the magnets, but this device does not give any assistance at the lower speeds, as the magnets ought to be so wound as to be high on the characteristic curve or nearly saturated with the normal current, and it is therefore not possible to obtain any increased intensity of field, by increasing the convolutions of the magnet coils. If it were possible to use alternate current motors for traction work, the difficulty could at once be met by introducing a transformer in the circuit, and placing the motor in its secondary. The effective convolutions of the secondary circuit could then be varied as the speed increases, in such wise, that the electromotive force of the line is balanced by the back electromotive force of the motor, and the fall of potential, due to the resistance of the motor coils, so avoiding all need for resistances.

The City and South London line has enabled experiments to be made on the efficiency of the railway system as a whole, taking into account the loss of power in the generators, on the line, and in the motors, and in the resistances of the locomotives. The loss in the line is about 11 per cent. of the power generated, and the efficiency of the locomotives as a whole is, as I have shown, 70 per cent.; thus the electrical efficiency of the entire system is 62 per cent. The trains weigh, with full load of 100 passengers, about 40 tons, and the average speed between stations is 13·5 miles per hour. The cost of working, including all charges, during last half-year, was 7·1d. per train mile, of which 4·7d. represents the cost of production of the electric power, and 2·4d. the cost of utilising it on the locomotives. It is perhaps hardly a fair comparison to compare the cost of working such a line as the South London line with the cost of steam traction on other lines, inasmuch as steam could not possibly be used in the tunnels, only 10 feet 6 inches diameter, in which this line is constructed; but the comparison is not uninstructive. Take the Mersey railway, where the gradients and nature of the traffic are similar. On the Mersey railway the locomotives weigh about 70 tons, and the train, which is capable of carrying about 350 passengers, 150 tons. According to the published returns of the company, the cost of locomotive power is 14d. per train mile, *i.e.*, double the cost on the South London line; but for a train weighing between four and five times as much, but capable of carrying only three and a-half times the number of passengers; thus the cost of steam traction per *ton mile* of train is about half that per *ton mile* of train for electric traction. But it is not on the cost per ton mile that the success of a passenger line depends. The real basis of comparison is the cost per passenger mile, and here electric traction has great advantage over steam, as the dead weight of the electric motor is small compared with the dead weight of steam locomotives of the same power, and with electric motors the trains can be slit up into smaller units at but slightly increased cost, so permitting a more frequent service. We cannot expect, therefore, that electric traction with our present knowledge will take the place of steam traction on our trunk lines, but it has its proper function in the working of the underground lines now projected for London, Paris, Berlin, and Brussels, and other large towns, and also, I think, on other urban lines, for example, on the Liverpool Overhead Railway, where trains of large carrying capacity are not required, but frequent service is essential; and finally, also, on those short lines, whether independent or branches of the great trunk lines where water power is available. When I undertook the construction of the Bessbrook line, it was a condition that the cost of working should be less than the cost of working by steam, a condition which the first six months of working showed to be successfully fulfilled. When Messrs. Mather and Platt undertook the construction of the electric plant for the City and South London Railway they guaranteed that the cost of traction for a service of 8,247 miles per week as actually run, should not exceed 6·3d. per train mile, exclusive of the drivers' wages. Their anticipations have been more than realised, the actual cost being 5·1d. per train mile only. There are, however, other projects both in America and on the continent for electric railways on which the special feature is to be an enormously high speed of travel, speeds of 150, and even 200 miles per hour, being promised. With a steam locomotive, involving the reciprocating motion of the piston and connecting rod, such speeds are probably unattainable, but they may be realised in the purely rotary motion of an electric motor. But at such high speeds as these, the power required to overcome the air resistance is a special consideration. Probably up to speeds of 750 miles per hour, or even to higher limits still, the ordinary law of air resistance holds good, as the rate of disturbance is still less than the velocity of waves in air, but above these limits we leave the regions of ordinary locomotion and enter rather into the field of projectiles. Assuming, however, that the ordinary laws of air resistances do hold good, I calculate that the power required to propel an ordinary train 200 feet long at 200 miles per hour against the resistance of the air alone, apart from the frictional resistances, would not be less than 1,700 horse-power. Though there is nothing to prevent the construction of electric locomotives capable of developing this, or even greater power, the strength of the materials at present at command will set a limit to the speeds which may be obtained.

In order that the engineer may realise the imperfection of all his works, it is well for him to be constrained from time to time to contemplate the amount of energy involved in his final purpose, compared with the energy of the coal, with which he starts. I have endeavoured to put before you to-night the losses that occur, and the reasons for them, in some steps of the complex machine, which constitutes an electric railway; so, in conclusion, I will draw your attention to the ultimate efficiency of the machine, starting with the coal and ending with the passenger carried through space. The diagram on the wall, starting with the familiar 12,000,000 foot-pounds, the energy of a pound of coal shows the loss in each step, supposing it made with the most economical appliances known to the engineer, first in the boiler, then in the steam engine, generator dynamo, conductors, locomotives, in the dead weight of the train, till finally we arrive at the energy expended on the passenger himself, which we find to be 133,000 foot-pounds, or but little more than 1 per cent. of the energy with which we started. It is true, indeed, that transportation is a more economical process than lighting with incandescent lamps, in which the final efficiency is about one-half per cent., but whether in lighting or in traction, when we consider that 99 parts are now wasted for one part saved, we may realise that the future has greater possibilities than anything accomplished in the past.

NOTES.

Cardiff Electric Lighting.—The bad gas lighting of Grangetown district was the subject of much discussion at a recent meeting of the Cardiff Town Council. The gas company have been communicated with regarding the matter.

Liverpool Electric Lighting.—The Special Committee has approved an agreement permitting the Liverpool Electric Supply Company to lay mains through Sefton Park, subject to confirmation by the Council.

Bradford Electric Lighting.—Major-General Carey held a Local Government inquiry last week with respect to application for power to borrow certain monies, among which figures £30,000 for electric lighting extensions.

Glasgow Electric Lighting.—The electric light in several of the principal streets in the centre of Glasgow was tested last week. The official inauguaration took place on Saturday. There are to be 108 arc lamps, of which 72 have been erected at regular intervals of 160 feet. These lamps are of the Brush Company's manufacture.

With the invitations issued for the inspection of the electric lighting machinery, on Saturday last, the Corporation also advised intending visitors to leave their watches at home, that they might not be injuriously affected by the dynamos.

"Deep Scrutiny" writes to the *Glasgow Evening News* as follows :—"Doubtless the electric light, as seen on Saturday night, is a great improvement, but the 'powers that be' have made a great mistake in the globe they have adopted. . . . . What is wanted is a full round white globe—this is the kind they have in Hanover, where the town is beautifully lit up. 'It's never too late to mend.'"

Elmore.—The following is a copy of a circular signed by Sir Thomas Farrer, Bart., Mr. W. Saunders, M.P., and Mr. Samuel Storey, M.P., which has been forwarded to the shareholders in the Elmore's French Patent Copper Company. This is a move in the right direction :—"After the recent special meeting at the Cannon Street Hotel, we received from the company, in common, we believe, with other shareholders, pressing applications for assistance. The enquiries which followed convinced us of the necessity for an immediate, impartial, and independent examination, on behalf of the shareholders, into the financial position of the company, and the probability of securing successful results under the Elmore patents. To make this enquiry effective it would be necessary to obtain the assistance of an accountant and an electrician, who in a few days would probably be able to supply the information which we need. It would be useless to call the shareholders together without first obtaining definite information. We, therefore, ask if you are in favour of this proposal, on the understanding that every shareholder supporting the enquiry will be invited to attend a meeting, either personally or by his representative, at which the results of the investigation will be stated, and future action considered. To meet the cost of this movement each shareholder is asked to contribute at the rate of 1d. per share on his holding. The total expenses incurred up to and inclusive of the date of the meeting will be limited to £100. Any surplus received will be dealt with as the meeting may determine. Mr. J. A. Robertson, of the firm of Messrs. Good, Son & Co., chartered accountants, of 57, Moorgate Street, E.C., would act as accountant, and Mr. Arthur Le Neve Foster, an experienced electrical engineer, of 61, Cadogan Square, would proceed to Dives to examine the works, and report upon their capabilities and value, also as to the cost of production. Major Jones, the present chairman, and Mr. F. W. Rawson (who is largely associated with the management of the company) have, on the part of the board, agreed to facilitate the enquiry by every means at their disposal, and, though unconnected with this action, they express themselves as not only willing but anxious to see the investigation efficiently carried through. Mr. Wm. J. Burnside, of 171, Queen Victoria Street, E.C., is acting as secretary to the movement, and will superintend the enquiries."

Kendal Electric Lighting.—The Kendal Town Hall News Rooms are to be fitted up with the electric light.

Aberdeen Electric Lighting.—Plans of new buildings to be erected in Cotton Street, and adjoining the gasworks, which are to contain the plant of the electric lighting scheme promoted by the Corporation, were passed last week at a meeting of the Plans Committee of the Town Council. The erection will cost £3,500.

Lectures.—On Wednesday evening last (March 1st) a lecture was delivered in Carpenters' Hall, London Wall, by Prof. Sylvanus Thompson, D.Sc, the subject being "Electric Lighting from a Popular Point of View." Sir Jas. Clarke Lawrence, Bart., occupied the chair.

The Architectural section of the Glasgow Philosophical Society met last Monday, when Mr. T. Crichton Fulton, electrical engineer, Glasgow, read a paper on "The Economics of Electric Lighting and Power Transmission."

The Inventor of Gutta-Percha Covered Wires.—The following further letter on this subject has recently appeared in the *Engineer* :—"Mr. A. Siemens has drawn my attention to the correspondence which has lately taken place in your columns as to the inventor of gutta-percha covered wires. As I was living with my brother Werner when he received the first sample of gutta-percha from London, I am perhaps better able than Mr. A. Siemens to deal with the letter of Mr. F. H. Danchell in your issue of the 10th inst. This sample was sent by my brother William immediately after he had received it at the meeting of the Society of Arts, when gutta-percha was first brought to the notice of that society. In my presence Werner began to cover a copper wire with the gutta-percha, and remarked that it seemed suitable for insulating purposes. I never heard at the time of anyone else bringing the gutta-percha to the notice of the Prussian Government excepting my brother Werner, and a report from the Commission to the Prussian Treasury Department, dated September 7th, 1847, declares my brother to be the first inventor. This report, among other documents, was laid before the American Commission as a proof that my brother was the inventor of gutta-percha insulation. Mr. Danchell brings no proof whatever in support of his assertion that he made similar proposals to the Prussian Government, and without these I do not see how he can substantiate his claim to priority. My brother Werner has throughout his life claimed to be the first inventor of gutta-percha insulation, and has publicly made his claim in articles contributed to various scientific reviews. Among these I will only mention a few, viz. :—*Mechanics' Magazine*, January, 1849; English Patent, No. 13,062, 1850; *Poggendorf Annalen*, 1850, Vol. lxxix., page 481; Academie des Sciences, Paris, April 15th, 1850; Royal Academie of Science, Berlin, July 2nd, 1874; Monthly Report of Royal Academie of Science, Berlin, December 7th, 1874. The model of the original machine constructed by my brother was exhibited at Vienna in 1873 by the Prussian Telegraph Office, and is now to be seen in the museum of the German Post Office. Dr. Edm. Hoppe, in his 'Geschichte der Elektricitat,' published in 1884 at Leipzig (Joh. Ambrosius Barth) expressly states, page 584, that my brother Werner is the inventor of gutta-percha insulation. Under these circumstances it appears very strange that Mr. Danchell never heard of my brother's claim to the invention as he asserts in his letter, but the facts and references quoted above prove that it is not my brother's friends who now claim it for him, but that the scientific world generally has always acknowledged his claim, and Mr. Danchell can scarcely expect that these proofs can be met by nothing stronger than his unsupported assertion to the contrary. With regard to the last sentence of Mr. Danchell's letter, my brother, as a Government official, neither took a patent for the covering machine, nor desired any benefit from its application, all contracts for underground cables being carried out by the firm of Fonrobert and Ruckner, in which my brother had no interest whatever. It is not necessary, therefore, to comment upon the reflections Mr. Danchell chooses to make on the friends of my brother. —Carl Siemens."

Sheffield Electric Lighting.—We hear that the Cutlers' Company have under consideration the redecoration of their hall, and the introduction into it of the electric light.

Lambeth Electric Lighting.—Lambeth Vestry has decided to negotiate for a site for a central station to light the parish with electricity, and to ask for power to borrow £75,000.

Newcastle Electric Lighting.—The lighting of Grey Street is to be the subject for discussion at a special meeting of the Lighting Committee. It is also to be considered whether it is advisable to recommend the Corporation to take into their hands the electric lighting of the city generally, which is at present supplied by private companies.

Hanley Electric Lighting.—The Local Government Board have sanctioned the borrowing of £21,000 for electric lighting purposes. They have also approved of the use of portion of the lands of Hanley Park for the site of the generating station. The Surveyor of the Town Council has been instructed to advertise for tenders for the erection of the necessary buildings.

Bournemouth Electric Lighting.—The Lighting Committee of the Town Council report that they have considered a tender from Messrs. Goddard, Massey, Warner & Co., for the additional work mentioned in the report of the committee, and they recommend that only a certain portion of the added work be carried out. The report has been adopted.

Chatham Electric Lighting.—At a meeting of the Chatham Corporation on Friday last, a letter was read from the local electric lighting company as to the proposed purchase of their works. The directors of the company stated that they were not in a position to go into the question at present, as their new works would not be completed for two months, and until the expiration of that time they could not ask the Corporation to go over them.

Manchester Electric Lighting.—Progress in connection with the electric lighting operations seems to be very slow. The time originally specified for the completion of the street work was August 1st, 1892, and we understand that everything is still in a very incomplete and unsatisfactory condition. A Manchester daily ventures the opinion that the central district will be lighted by the month of June next, 10 months later than was at first intended!

Leicester Electric Lighting.—If the words of a correspondent of the *Leicester Post* are correct, electric lighting will meet with a good deal of opposition from the hands of the ratepayers. The following is an abstract of the letter referred to:—"Permit me to ask who wants the electric light? Our gas is cheap and good, and I am sure it would suit the ratepayers far better to have more lamp posts put up with larger burners than fool away £50,000 in another form when the extra burners would not cost as many shillings. . . . Why should such positive waste of money (considering the finances of the town) be tolerated by the ratepayers? We ought to be advertised as a set of idiots to countenance such a thing now. Use your pen on behalf of us poor sufferers."

Telegraph and Telephone Interruptions.—On Sunday last there was a severe snowstorm in the North which had a rather serious effect upon the telegraph service. Generally speaking, the entire east coast service, extending from Aberdeen to London, was almost completely at a standstill, communication with the metropolis being only available by the west coast. By 9 o'clock at night Aberdeen was wholly cut off from communication with the south. The telephone wires have also suffered considerably, and it is said that seldom has there been such a collapse.

The Eastern Telegraph Company, Limited, announces that the Aden-Zanzibar cable having been repaired, telegraphic communication is restored with Cape Colony and other parts of South Africa.

Brighton Electric Lighting.—A Board of Trade enquiry is to be held at Brighton next Tuesday concerning the application for additional powers by the Brighton and Hove Electric Light Company. Major Cardew and Mr. Ingram B. Walker will hold the enquiry.

Huntley Lighting.—When the question of the purchase of the gas works by the Local Board was under consideration a few days ago, one of the members said it was not advisable to purchase this undertaking in face of the position of electric lighting. The matter therefore lies "on the table" for the present.

Telephonic Communication in Manchester.—A Manchester daily understands that a working arrangement has been entered into between the National and Mutual Telephone Companies, the two systems which are in operation in Manchester, which may eventuate in the amalgamation of those enterprises.

Liquefaction of Ozone.—Ozone is a little less easily liquefied than carbon dioxide. The mixture of oxygen and ozone must be cooled when compressed, or heat is generated, and a violent explosion follows, accompanied by heat and a yellow light. Berthelot has shown that the heat of formation of ozone is 14·8 calories (equivalent of ozone = 24), and the experiments of Hautefeuille and Chappius show that it is also explosive. The fact can be partly observed at ordinary temperatures; for if the gas obtained from the electrical apparatus be passed into a capillary tube, placed in water at 25° C., and rapidly compressed, ozone is often destroyed with an explosion. If the same is maintained at − 23° C., and under 10 atmospheres pressure, it can be kept for hours, if separated from the mercury by a layer of sulphuric acid. The azure colour, which is as characteristic of ozone as its odour, is visible at all tensions, if the gas is in sufficiently thick layers. Hautefeuille and Chappius endeavoured to obtain ozone as a permanent liquid. At − 23° C., and under 200 atmospheres pressure, the gas was blue, but no liquid appeared. A part of the tube was then cooled to − 88° C., and the colour appeared three or four times as deep as it was at −23° C. The mercury was frozen, and not acted upon by ozone; but *there was no liquefaction*. A large proportion of carbon dioxide was then added. At − 23° C., and with a slow increase of pressure, a blue *liquid appeared*, of the same colour as the gas above it. This liquid was permanent, while the pressure remained the same, being a *solution of ozone in liquid carbon dioxide*. Encouraged by this result, Hautefeuille and Chappius experimented again on the liquefaction of ozone. By compressing a mixture of oxygen and ozone to 125 atmospheres in a cailletet apparatus, they obtained *ozone in drops* of a deep indigo colour. This liquid was preserved for more than half-an hour under a pressure of 75 atmospheres; its evaporation is slow, but it diffuses rapidly.

Accrington Electric Lighting.—At the Accrington Town Hall on Wednesday, a Local Government enquiry was held regarding an application of the Corporation to borrow £10,000 for the purpose of electric lighting. It was stated by the Town Clerk that it was not intended to light the streets generally with the electric light at the outset, but to confine it to public buildings and the outside illumination of such places. There was no opposition to the application.

Shoreditch Electric Lighting.—At a special meeting last Tuesday the Shoreditch Vestry had before them a scheme, prepared by Mr. E. Manville, for supplying electricity for public and private lighting and power purposes, and combining the generating station that would be required for the same with furnaces for the utilisation of the ash-bin refuse of the parish. The report was unanimously adopted, and a special committee elected to carry out the work, which is estimated to cost £63,000 (exclusive of the cost of site). The vestry are at the present time paying £3,000 per annum (3s. per ton) for the disposal of the house refuse of the parish, and by the scheme this will be all used up by the dust destructor, while no expenditure will be involved on account of coal for the engines.

Mandalay Electric Lighting.—Mr. Whelan, an enterprising tramway projector at Mandalay, has submitted a plan for lighting the town with electricity.

Ealing Electric Lighting.—Judging from several letters appearing in the *Middlesex County Times*, there will be some opposition from the ratepayers to the electric lighting scheme.

Portraiture.—The *Machinery Market* for March contains an ink-photo portrait, reproduced from a photograph, of Mr. W. C. Mountain, M.I.C.E., of Messrs. Ernest Scott and Mountain, Limited.

Leeds Electric Lighting.—The Yorkshire House-to-House Electricity Company are beginning to extend their mains in various directions. Numerous connections to the mains completed a few weeks ago have been made in various parts of the city, and many others are in hand.

Blackburn Electric Lighting.—On Tuesday 28th ult., at the Blackburn Town Hall, Mr. Rienzi Walton, M.I.C.E., a Local Government Board Inspector, held an inquiry into the application of the corporation for sanction to borrow £50,000 for electric lighting purposes.

Ogmore Electric Lighting.—At the Ogmore and Garw Local Board last week, it was reported by the surveyor that the time which the board had conditioned with the Ogmore Electric Company for the maintenance of street oil lamps had expired. The surveyor recommended that the lamps and lanterns should be taken down and stored.

Argentinal Electric Lighting.—MM. Commelin and Co. have formed a company for electric lighting at Argentenal. The capital consists of 450,000 francs in 900 shares. The company will make use of a new accumulator constructed of *cadmium* (!) and it will have the use of a new meter invented by M. Commelin.

The Baker Street and Waterloo Electric Railway.—The Bill authorising the construction of an underground electric railway from Baker Street to Waterloo Station came before Lord Morley last Tuesday, when formal proof of some minor amendments was given. This scheme will now in due course receive the Royal assent.

Specification of Electric Plant for Open Competition.—In this issue we publish the first of a short series of articles on this subject, which have been prepared by Mr. Thomas Tomlinson, who has had a lengthened practical experience as a contractor's engineer in working to specifications of various forms. Our Correspondence columns are open to discussion on this all-important question.

Rotherham and District Electric Lighting.—It is proposed to appoint a special committee to enquire into and report to the Town Council upon the cost of an electric lighting plant, the most suitable site for the same, the probable revenue, and any other information likely to assist the Council in deciding whether it is advisable to establish the electric light in the borough.

Turin Electric Lighting.—The Piedmontese Electric Company, which was formed at Turin in 1890, with a capital of 1,800,000 lire, has bought from the Societa Generale per l'Illuminazione di Roma, for 1,850,000 lire, the installation for the electric lighting of Turin, which originally cost 2,700,000 lire, and which possesses a concession up to December 31st, 1906.

The Institution of Electrical Engineers.—On Thursday, March 9th, 1893, the discussion on "Notes on Testing Alternators," by W. M. Mordey, will be continued.

Society of Arts.—Prof. Chandler Roberts-Austen will commence a course of three "Cantor" lectures on "Alloys," at the Society of Arts, on Monday next, March 6th, at 5 o'clock. The remaining lectures will be given on the two following Monday afternoons at the same hour.

The Goebel Defence Rejected.—We publish elsewhere in this issue the terms of the Goebel Defence. We learn from the American mails just to hand, that the evidence of Goebel has been rejected, and therefore an injunction is granted against the Beacon Vacuum Pump and Electrical Company in the suit for infringement of the Edison lamp patent.

West Cowes Electric Lighting.—At the last meeting of the Local Board a letter was read from the secretary of the electric lighting company, stating that the Board's letter had been read at a meeting of the directors, and he was instructed, in reply, to ask the Board to postpone any action for the present, as the company was taking steps which they had every reason to believe would prove successful to obtain the necessary capital within a short time. The difficulty the company had met with was largely due to the fact that the Board of Trade, contrary to precedent, had not yet granted the actual license, and consequently the company had met with difficulties they had not anticipated. Mr. White moved that the company be given four weeks, and that at the end of that time the Board take what action was necessary. This was agreed to.

Recent Researches on Magnetic Rotation.—The many points of similarity which exist between the refractive indices and magnetic rotations of substances, have suggested to Prof. S. U. Pickering, F.R.S., the enquiry whether, in the case of sulphuric acid solutions, the refractive indices would yield results similar to those obtained by Dr. W. H. Perkin with the rotations of such solutions, which have recently been noticed in the Electrical Review. Taking Van der Willingen's measurements of the refractive indices of the acid, Prof. Pickering proceeded to construct curves showing the refractive indices and molecular volumes at various strengths of solution. Various breaks were noticed in these curves, the more prominent of which approximate very closely to those observed by Dr. Perkin in the curves of magnetic rotation. A remarkable curvilinear figure was obtained in a second examination with density determinations. These determinations are in harmony with those of the refractive indices, and correspond with those of the magnetic rotations as closely as the larger magnitude of the experimental error with the latter property would lead us to expect. Thus Prof. Pickering's work supplies further evidence that all the properties of a given substance show more or less sudden alterations at certain points, and that however dissimilar the figures formed by these properties may be, they are all consistent in the positions indicated by them for these changes. We might wish that the determinations of the magnetic rotations and refractive indices were sufficiently numerous to show whether in minor details, as well as in their more general indications, they agree with Prof. Pickering's results obtained in his examinations of other properties. The enormous labour entailed in determining the magnetic rotations almost precludes the hope that Dr. Perkin will ever make his series more complete; the determinations of the refractive indices, however, would prove a much easier task, and provided sufficient care were taken to keep the temperature and strengths of the solutions constant, further important contributions to our knowledge of this subject would doubtless follow.

Donovan Appeal.—The Master of the Rolls and Lords Justices Lindley and Bowen heard an appeal in the action of Donovan *v.* Laing, Wharton and Down Construction Syndicate yesterday, against the decision of Mr. Baron Pollock in favour of the defendants. The appeal was dismissed with costs.

The Paris Professional Syndicate of the Electric Industries.—At a meeting on February 7th, the rules were made more stringent. They are now as follows: The director of the Office of Control is interdicted from acting as a projector or manufacturer of electric appliances, and from accepting any interest in a house which undertakes or constructs electric installations, comprising everything from a meter to a lamp, inclusive.

Lang v. House-to-House Electric Light Company.—The further hearing of this case was resumed yesterday. It will be remembered that this was an action by Mrs. Lang to recover damages sustained by the death of her husband, who was killed while working on a live main. After much evidence had been heard on both sides a verdict was given for the defendants.

The Royal Society.—The following paper was down for reading before this Society last evening (March 2nd):—"The Effects of Mechanical Stress on the Electrical Resistance of Metals," by J. H. Gray and J. B. Henderson.

NEW COMPANIES REGISTERED.

Mazarron Electric Light Company, Limited (38,277).—This company was registered on the 27th inst. with a capital of £15,000 in £1 shares, to establish electric lighting for the town of Mazarron, in the province of Murcia, Spain, or elsewhere, and to acquire a concession dated September 6th, 1892, granted to Mr. Santiago Olivera y Bazterrica, of Mazarron; to enter and carry into effect a certain agreement, and to generate or produce electricity and electric force, and to distribute the same; to light public or private buildings in all parts of the world; and to deal in apparatus and instruments for electric lighting. The subscribers (with one share each) are: A. H. Shaw, Lewisham, S.E., solicitor's clerk; N. T. Hemming, Peckham, S.E., clerk; G. Profaze, Holloway, solicitor's clerk; E. A. King, South Hackney, solicitor's clerk; S. W. Richard, Beckenham, clerk; A. Wm. Boon, 22, Coalharbour Lane, S.E., solicitor's clerk; J. T. Thompson, South Newington, artist. The number of directors is not to be less than two nor more than five; qualification, £10. The first directors, who need not hold any qualification, are to be W. B. Kingsford and S. W. Richard; remuneration, £50 per annum each, and 5 per cent. on the amount applicable to dividend to the ordinary shareholders. Registered by Romer and Haslam, 4, Copthall Chambers, E.C.

London and Lancashire Electric and General Engineering Company, Limited (38,281).—This company was registered on the 27th inst., with a capital of £20,000 in £5 shares, to acquire the property and effects of the business of electrical engineers now carried on by W. R. Pryke and Wm. Palmer under the style of the London and Lancashire Electric Company; to enter into a certain agreement; to supply electricity and to carry on the business of electricians in all its branches. The subscribers (with one share each) are: Wm. R. Pryke, 48, Upper Thames Street, E.C., hardware merchant; Wm. Palmer; T. J. Hodgson, 17, Little Trinity Lane, E.C., stationer; J. C. Wattler, Brockley, S.E., ironfounders' agent; W. E. C. Pinchbeck, 71, Queen Street, E.C., merchant; F. A. Franklyn, E. Dulwich, S.E., accountant; J. A. Hadley, Birmingham, manufacturer. The rules of Table A are usually applicable. Registered by J. D. Peard, 13, Sise Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

International Electric Subway Company, Limited.—The registered office of this company, which was formerly situated at 43, Threadneedle Street, E.C., is now at Albany Buildings, 39, Victoria Street, S.W.

Emile Lansard Syndicate, Limited.—A meeting of this syndicate was held at 216, Goswell Road, E.C., on the 13th ult., when it was resolved to wind up the concern voluntarily. Mr. J. Boss, of 9, Fleet Street, E.C., was appointed liquidator.

Fowler Lancaster and Company, Limited.—The annual return of this company has just been filed, and shows that out of a nominal capital of £22,000 in £10 shares, 1,782 shares have been taken up, of which 620 were issued as fully paid. Upon the remaining 1,162 shares the full amounts were called, and all calls, reaching £11,620 paid.

Islington and General Electric Supply, Limited.—The annual return of this company has been made up to January 12th, and shows that the concern was registered on June 28th, 1890, with a capital of £1,000 in £1 shares as the "Camberwell and Islington Electric Light and Power Supply, Limited." The capital was subsequently increased to £250,000 in £5 shares by the creation of new shares. The public issue was unsuccessful, and at the time of making up only 27 shares had been taken up, resulting in a payment of £107.

Mountain's Wire Manufacturing Company, Limited.—Messrs. Leatham, Tew & Co., bankers, of Pontefact, presented on the 15th ult. a petition for the compulsory winding up of this company. The hearing will take place at the Royal Courts of Justice on March 11th.

St. James's and Pall Mall Electric Light Company, Limited.—The annual return of this company, made up to the 8th ult., shows that out of a nominal capital of £200,000, in 100 founders' shares of £1 each, 19,980 ordinary shares of £5 each, and 20,000 £7 per cent. preference shares of £5 each. All these shares have been taken up, the full amount called, and all calls paid.

Lithanode and General Electric Company, Limited.—The statutory return of this company has been made, and shows that out of a nominal capital of £100,000 in £1 shares, 17,725 shares have been taken up. There has been 18s. paid on each of these, and the amount of calls received is £998 3s. The sum agreed to be considered as paid is £14,180. The calls unpaid reach £774 7s.

Lironi and Bowman Company, Limited.—The statutory return of this company has been made, and shows that out of a nominal capital of £2,500 in £1 shares, 2,000 shares have been taken up. There has nothing been called up, but the amount agreed to be considered as paid on 2,000 shares is £2,000.

London Battery Company, Limited.—The registered office of this company is now situated at 1 and 2, Marlborough Road, Charlotte Street, Blackfriars, S.E.

London Electric Manufacturing Company, Limited.—The registered office of this company is now situated at 50, Old Broad Street, E.C.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bristol.—March 15th. For the supply, delivery, and erection of switchboards, terminal boards, transformers, and other apparatus at the central electric lighting station and sub-stations for the Bristol Urban Sanitary Authority. Further particulars from the Town Clerk, 51, Prince Street, Bristol.

Dewsbury.—March 25th. Construction, supply and laying down of the necessary plant and mains for the supply of electricity in the borough. Further particulars in our advertisements.

Erfurt (Prussia).—March 4th. For various descriptions of electrical conductors and telegraph stores for the Prussian Royal railways. Further particulars from the Director of Stores, Erfurt, Prussia.

Swindon.—May 1st. The Local Board for electric lighting the district for seven years from January 1st, 1893, the contractors to erect all necessary machinery and plant. Further particulars from Mr. W. E. Morris, district surveyor, Swindon

Wallasey.—March 14th. The Wallasey Local Board are prepared to receive tenders for diverting the route of telegraph line used in connection with the existing water level electrical gauge, and renewing the wire for a distance of about 1,220 yards. Specification and plan of the route may be seen, and all information obtained on application to the engineer, Mr. H. Ashton Hill, Assoc. M.I.C.E., at the Waterworks, Great Float, near Birkenhead.

BUSINESS NOTICES, &c.

The Accumulators on the Birmingham Central Tramway.—It must be a matter for congratulation and unalloyed satisfaction to the Birmingham Central and other tramway companies in want of a really serviceable accumulator for traction work, and to the manufacturers especially, that the very favourable prognostications which accompanied the appearance of the Epstein cells have been so fully borne out by that stern and unimpeachable authority "extended practical experience." Great credit is undoubtedly due to the directors of the Birmingham Central for acting so pluckily on the strength of their convictions in adopting a new cell for their service at a time when the path was strewn with dismal failures, and when accumulators were gradually falling into hopeless disrepute. We are right glad to be able to applaud a selection which, from the excellence of the results, shows remarkably sound judgment. Of course, other tramway companies who have been laying low and watching events, will get the benefit of the Birmingham experience, and small blame to them; this is an instance of unearned increment with which we are not inclined to quarrel. The records of the Epstein cells at Birmingham present interesting reading. Several of the batteries which started on their trips last August are still on the road in their pristine condition, doing useful service and having each completed their 4,000 car miles. We understand that 2,800 car miles run suffice, at the stipulated maintenance rate of 1½d. per car mile, to re-imburse the manufacturers for the renewal of the positive sections. From these results it is evident that the Epstein Company, not merely is on the right track—which, in itself, is a good thing—but has actually succeeded in converting a delicate apparatus into a robust piece of machinery capable of doing hard work, doing it well and economically; and traction work is, without doubt, the severest work to which accumulators can be put. Under normal conditions of the road the discharges on stiff inclines already considerably exceed the maximum rates indicated in the lists, but when the roads are covered with snow and ice, as during last December, the energy expenditure all along the line, and especially on the inclines was three times as high as that under ordinary circumstances. To put it more plainly, discharges at the rate of about 200 ampères were taken from cells, the total capacity of which, if discharged at 40 ampères, is only 170 ampère hours. Yet the Epstein cells were equal to the task thrown upon them, and enabled the management to keep up a regular and uninterrupted service. With such satisfactory and reliable data as basis, and all doubts and fears regarding capabilities and cost of renewals of the cells definitely eliminated, electric traction by means of accumulators cannot fail to advance by leaps and bounds, and to develop into one of the most important branches of electrical engineering.

Asylum Electric Lighting.—Messrs. Ernest Scott and Mountain, Limited, of Newcastle-on-Tyne, have secured the contract for the electric lighting of Craig House, Edinburgh. Craig House is one of the largest, if not the largest private lunatic asylum in England or Scotland. The installation will consist of two Lancashire boilers, 25 feet long by 7 feet 6 inches diameter, four horizontal compound engines, each capable of giving 60 H.P., four Tyne compound-wound dynamos, each capable of running 400 16-C.P. lamps and between 1,300 and 1,400 incandescent lamps and fittings. We are informed that Messrs. Scott & Mountain are busier than they have ever been in their electrical department. Amongst important contracts in hand at the present time may be mentioned the lighting of the Co-operative Wholesale Society's premises at Waterloo Street, Newcastle, this installation consisting of three Crossley gas engines of 25 nominal H.P., and three 400-light dynamos and about 1,200 16-C.P. lamps. Also the lighting of Mr. John Dickenson's engine works at Sunderland, the plant in this installation consisting of 2-unit Tyne compound wound dynamos and 39 arc lamps of 2,000 and 3,000 C.P., with about 120 incandescent lamps. They have also in hand the lighting of Barnby Manor, Newark, the residence of Mr. Frederick Platt, and a large mansion in course of erection at Kirkby Lonsdale, for Dr. T. Paget Tomlinson, and the firm are now building two large sets of combined engines and dynamos, each of 400 ampères output, for cruisers, building by Messrs. Sir W. G. Armstrong, Mitchell & Co. Amongst mill installations may also be mentioned the lighting of Messrs. Chadwick Brothers & Co.'s new spinning mills at Bolton, and their spinning mills at Riga, Russia.

Electrical Fire Alarms.—Last week, the Mayor of Derby formally opened the electrical fire alarms recently constructed in different parts of the town. They are 16 in number, and in their construction 17¼ miles of wire have been used, together with 594 insulators. The work has been carried out by Mr. Rowbottom, of Abbey Street, at a cost of £200.

Theatre Electric Lighting.—Messrs. T. L. Hemming & Company have secured the contract for the electric lighting of the Queen's Theatre, Snow Hill, Birmingham. Two 3,000 C.P. arc lamps will be fixed at the entrances to the theatre, and lights of the same power will be fixed in the body of the theatre and over the stage. There are a number of small incandescent lamps for the footlights, &c.

Catalogues, &c.—As we recently announced, the Edison and Swan Company had opened several additional provincial establishments, and were also trading in electrical fittings and apparatus, wires, cables, &c., of every description, as well as their ordinary lamp business. The company have now issued a price list (Section IV.) which deals with wires, cables, casings and sundries. The chief portion of the book is devoted to particulars of electric light wires and cables. An illustration is given of a bird's eye view of the works at Ponder's End, and another of the offices at the same place.

Messrs. Swinburne & Co., Limited, have just published a catalogue relating to their manufactures, dynamos, condensers, transformers, galvanometers, and general electrical apparatus are detailed. The illustrations, of which there are a good number, are clear, and the printing has been nicely done, and on the whole the catalogue is a very good one. In the front of the book are printed autographs of the chairman and directors of the company.

Business Announcement.—The directors of the Grusonwerk, Magdeburg-Buckau, have concluded a contract with the firm of Fried. Krupp, of Essen, which gives the latter the right of working the former company's factories, and this contract has obtained the assent of shareholders at a general meeting held on the 10th ult. According to the provisions of this contract, the Grusonwerk continues to exist as an independent company under the management of the same board of directors. The latter will, however, act in accordance with the instructions of the firm of Fried. Krupp, which in return guarantees the shareholders of the Grusonwerk a fixed annual dividend. These instructions provide that no alterations will take place in the management of the Grusonwerk. The following directors will, therefore, continue to cultivate the connections of the works in the same manner as before, and do their best to develop its efficiency in every direction, maintaining the principles which have hitherto led the Grusonwerk to success:—E. Dossmann, Dr. H. Gruson, Spoerl, E. Reimers, Klemperer.

Rashleigh Phipps & Co.—Messrs. Rashleigh Phipps and Co., of 102, Oxford Street, W., have secured contracts during the past few weeks for the following installations:—New works at Canning Town of the Lamson Paragon Supply Paper Company, complete plant; Messrs. Mooney & Co., of Dublin, new depot, 19, High Holborn; W. G. Curryer, boot warehouse, 69, Oxford Street; new depôt for Messrs. Hudson Brothers, 40, High Street, Kensington; L. S. Myers, Esq., 5, Grafton Street, W.; Dr. Luff, 31, Weymouth Street; Dr. Hutchinson, 1, Park Crescent; Dr. Dolamore, 37, Queen Anne Street; Dr. W. Adams Frost, 17, Queen Anne Street. They have also been putting in new batteries at Messrs. Marshall & Snelgrove's large premises in Oxford Street, to supply additional lighting. The additional works in the City are the Buenos Ayres Great Southern Railway Company, 6 and 7, Finsbury Circus, and Messrs. Shepheards, 31 and 32, Finsbury Circus.

Stone Casings for Underground Cables.—Messrs Doulton & Company, of Lambeth, have lately brought out a new patent casing for underground insulated cables. This casing is of highly vitrified stoneware, which material is said to offer advantages over any other for use underground. It possesses great strength, is impervious to water and gas, and the material is absolutely imperishable, being, capable of withstanding the action of the strongest acids. It is also unaffected by changes of temperature. The casing is made in lengths of three feet or less, with two or more separate ducts, the interior surface of which possessses a hard and smooth glaze, presenting exceptional facilities for drawing cables in and out of the "ways." The casings may be laid in a group to form a conduit of any desired capacity. Several methods of joining the lengths of casing have been designed, each offering special advantages.

Sale by Auction.—On Wednesday next, March 8th, Messrs. Wheatley Kirk, Price & Goulty will conduct a sale by public auction at the electric tramcar station known as Plashet Hall Works, Romford Road, Forest Gate, E. There will be offered a number of electric motor tramcars, dynamos, and a variety of plant and effects, the entire contents of the above works. There will also be a sale at the same place of a number of new machine tools, engines, dynamos, plumbers' and electrical fittings.

Maple and Company, Limited.—This company, in addition to being busy on several domestic installations in London, have a very large contract at Lichfield for supplying engines, plant, dynamos, and all necessary fittings for a complete installation. They are also busily engaged with the wiring of the Hotel Burlington, at Boscombe, where they hope to have the light installed in the course of the next few weeks.

Companies in Liquidation.—It has been decided to wind up Fowler, Lancaster & Co., and The Birmingham Telegraph Factory Company in liquidation. The concerns are allied in interest, and purely private, comprising only friends as shareholders. Considerable capital has been lost in litigation. Mr. James Rhodes, Waterloo Street, Birmingham, is the chartered accountant appointed as liquidator.

Reduction in Telegraph Rates.—The Great Northern Telegraph Company announce a reduction in the rate for telegrams to China. On and after March 1st next, the present rate by this company's route of 7s. 6d. per word to Canton and 8s. 9d. to other stations will be reduced, and the rate to all stations in China will be 7s. per word. The rate to Macao remains unaltered, *i.e.*, 7s. 6d. per word.

Norman & Son.—This firm (Glasgow) have secured the contract for the electric installation of the new Glenburn Hydropathic at Craigmore (Bute).

Batavia Exhibition.—We have received from Messrs. J. Birch & Co. some particulars regarding the exhibition to be held shortly in Batavia. It seems that up to the present, applications from English firms for space have been singularly few; that, to all intents and purposes the exhibition, with its present prospects, may be called a German one; that German firms have proposed to do the electric lighting of the exhibition, and that German firms have offered to provide sufficient petroleum motors to drive the whole of the machinery. The particulars given us by Messrs. Birch include a note of apparatus suitable for exhibition; time goods are to be delivered at Batavia, and detailed instructions to exhibitors. Messrs. Birch, who have been asked to take the matter up in England by the Exhibition authorities, will be pleased to furnish any information at 10 & 11, Queen Street Place, London, E.C.

General Electric Company, Limited, v. Rooper and Tozer.—In this case, which came before Mr. Commissioner Kerr on 23rd ult., Mr. E. B. Tattershall appeared for the plaintiff company, who claimed £2 3s., the balance of £20 8s. for an electric lamp made specially to the order of the defendants, Messrs. Rooper & Tozer, engineers, of 11, Bridge Street, Northampton. Mr. Nathan Goodman, secretary of the plaintiff company, spoke to the lamp having been made as ordered by the defendants. Mr. Tozer, one of the defendants, said the charges were excessive. They were higher than the terms of other firms in the same trade. The learned Commissioner found for the plaintiffs, giving the defendants leave to have the case tried by a jury.

Blakey, Emmott, and Company, Limited.—At an extraordinary general meeting of the abovenamed company, held at the offices of Lakeman and Oliver, Imperial Buildings, Bond Street, Leeds, on February 23rd, 1893, the following extraordinary resolutions were duly passed, namely:—1. That it has been proved to the satisfaction of this meeting that the company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and that the company be wound up voluntarily. 2. That James Lakeman, of 30, St. Swithin's Lane, London, E.C., be appointed liquidator.

Electricity at the Agricultural Hall.—On Friday last, at the Clerkenwell County Court, before Judge Eddis, Field Trickett, an electrical engineer, of 43, Theberton Street, sued Messrs. H. and J. Read and J. Bailey, amusement contractors, for £15 14s., for 31 weeks' hire of 100 yards of electric cable, and £10 damages. The Judge made an order for the return of the cable, allowed the plaintiff £2s. 6s. damages, an amount which he also ordered the plaintiff to pay to the defendants.

Annual Dinner.—The General Electric Company, held their third annual dinner on Saturday last at Broad Street Station Restaurant. Mr. G. Binswanger being in the chair. Afterwards a most successful smoking concert was held.

Automatic Sprinkler.—On Friday last, before Dr. E. Hopkinson delivered his lecture on "Electrical Railways," Edwarde's patent automatic revolving sprinkler was shown in the library by special request of the Royal Institution.

Exhibition Lighting.—An estimate was accepted from Messrs. Fowler, Lancaster & Co., for lighting the Redditch Institute Exhibition building with electricity.

CITY NOTES.

Chelsea Electricity Supply Company, Limited.

THE directors' report reads as follows:—"The directors beg to submit to the shareholders the report and statement of accounts for the year ended December 31st, 1892. The net profits for the year, after paying debenture interest, amount to £1,336 2s. 7d., out of which it is proposed to pay a dividend on the ordinary shares at the rate of 2½ per cent. per annum, carrying forward the sum of £176 10s. 1d. to next year. In considering these results, it must be remembered that a large proportion of the company's capital is in the form of debentures. To meet the necessary increase in capital expenditure, the balance of the first mortgage debentures and £3,700 of the second debentures were issued during the year, as the money was required for new works. Important additions have been made to the plant and various improvements have been effected. The whole of the plant, including the accumulators, is in thorough working order. A very gratifying feature of the accounts is the large saving shown in the consumption of coal. There were 357,162 units of electricity sold during last year, the expenditure on coal being £2,433, as against £2,692 in 1891, when 290,459 units were sold. The total cost of each unit of electricity sold was 5½d. in 1892, as against 7d. in 1891. The number of lamps on the company's mains at the end of 1892 was 34,876, being an increase of 27 per cent. for the year. The directors have every confidence that the accounts for the current year will show still further improvement. The transfer of the company's area in South Kensington was, subject to the confirmation of parliament, approved at the extraordinary general meeting held on the 14th inst. The directors are of opinion that this transfer will be of advantage to both companies. In May last Mr. Frank King was appointed managing engineer of the company, and the appointment has already produced very satisfactory results. The retiring directors are Sir George Prescott, Bart., and Mr. E. Garcke, who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers and Co., also offer themselves for re-election.

ABSTRACT OF ACCOUNTS to December 31st, 1892.

CAPITAL ACCOUNT.

Dr.	£	s.	d.
To Expenditure per last account	74,720	17	0
„ Further expenditure to December 31st, 1892 ...	6,643	1	6
	£81,363	18	6

Cr.	£	s.	d.
By Ordinary shares, £5 each	46,385	0	0
„ Founders' „ £1 each	500	0	0
„ Debentures	33,700	0	0
	£80,585	0	0

REVENUE ACCOUNT.

Dr.	£	s.	d.
To Generation of electricity	4,766	3	7
„ Distribution of electricity	1,037	5	8
„ Proportion of rent, rates, and taxes	516	10	7
„ Proportion of management expenses	1,798	4	8
„ Proportion of law and Parliamentary charges ...	2	16	0
„ Special charges	83	6	8
„ Balance	4,318	18	10
	£12,523	6	0

Cr.	£	s.	d.
By Sale of current per meter ... „ „ „ under contract }	11,905	8	6
„ Rental of meters, converters, &c.	410	14	8
„ Transfer fees	0	17	6
„ Other items	206	5	4
	£12,523	6	0

NET REVENUE ACCOUNT.

Dr.	£	s.	d.
To interest on debentures	1,843	2	6
„ Fees to trustees for debenture holders	100	0	0
„ Renewal fund	1,000	0	0
„ Other items	171	13	9
„ Balance	1,336	2	7
	£4,450	18	10

Cr.	£	s.	d.
By Balance from account	132	0	0
„ „ „ revenue account	4,318	18	10
	£4,450	18	10

RESERVE FUND.

Dr.	£	s.	d.
To Renewals	1,000	0	0
	£1,000	0	0

Cr.	£	s.	d.
By Amount carried to net revenue account	1,000	0	0
	£1,000	0	0

GENERAL BALANCE-SHEET.

Dr.	£	s.	d.
To Capital account	80,585	0	0
„ Sundry tradesmen and others, on construction of plant, machinery, fuel, &c.	2,482	0	1
„ Sundry creditors on open accounts...	3,809	6	10
„ Net revenue account, balance at credit thereof ...	1,336	2	7
	£88,212	9	6

Cr.	£	s.	d.
By Capital account	81,363	18	6
„ Cash at bankers „ „ in hand }	642	5	9
„ Sundry debtors for current	5,436	9	9
„ Stores on hand	769	15	6
	£88,212	9	6

The annual meeting of the shareholders of the above company was held on Thursday at the central station, Draycott Place, Sloane Square, S.W., Mr. J. Irving Courtenay, the chairman, presiding.

The report having been taken as read,

The Chairman said: Before moving the adoption of the report and accounts, I will direct your attention to some points that seem to me worthy of special consideration, and will say a few words on the general position of the company. The net revenue for the year, after deducting debenture interest, is £1,336 2s. 7d., out of which it is proposed to pay a dividend on the ordinary shares of 2½ per cent. This is not a large dividend, but it is in addition to the payment of a heavy debenture interest, and may be taken as an earnest of the future. You are aware that a considerable portion of the company's capital is in the form of debentures. I will point out here that the net profits in 1891 were only 7½ per cent. of the gross, but in 1892 the net profits were 31 per cent. of the gross. The improvement in the company's position which we looked forward to has now to some extent been attained, and you will observe that the gross revenue approximates to the estimate I gave last year. The substantial progress made each year in the profits is shown by the fact that the debenture interest provided for in the last three years was in 1890, £530; in 1891, £1,206; and in 1892, £1,843 in addition to the net profit just mentioned. You will notice that as our capital expenditure has increased, so also have our profits increased in a much larger proportion. The increase in capital expenditure is moderate in comparison with the figure it may reach before we arrive at the limit of profitable investment in Chelsea. The capital expenditure equals £2 6s. 6d. per lamp installed, which will compare favourably with the capital outlay of any other electric lighting company. We have increased our lamps during last year without any large extension of the mains, and the percentage of increase in revenue has been nearly as large as the increase in the number of lamps. The other items in which the capital has been laid out have entirely justified the expenditure by the benefit already reaped, and we have the best reasons for expecting a still larger return on this expenditure during the current year. Besides some extension in mains, the enlargement of existing mains, and the necessary addition to our stock of meters, we have added to our plant two boilers and a pair of feed-water heaters; we built an extra bunker for the storing of coal, also an additional exit from the engine room in case of accident, and made some additions and alterations to all the boilers, which have been productive of large economy in working. We have enlarged the building of our Clabon Mews sub-station, and placed there an additional continuous current transformer. These transformers were supplied by the Electric Construction Corporation Limited, and have continued to work in an eminently satisfactory manner. They are used in addition to the accumulator plant, and not in substitution for it, and we have found the combination entirely fulfil the expectations formed at the time of the original design of the system by Mr. Frank King; a system which enables us to afford our customers a regularity of supply of a quality nowhere surpassed. The plant has all been maintained in a thorough condition; indeed the nature of the business is such that were this not done the supply could not be kept up. The storage batteries are in excellent condition, and the mains of Callender's bitumen cable have stood the test of now nearly four years underground, the insulation being still quite satisfactory. On a former occasion when I addressed you I alluded to the heavy consumption of coal, and stated that it was not due, in my opinion, to any fault of the Chelsea system. The words I then used are now being justified. The directors have continued to give unremitting attention to this point and have succeeded with the able assistance of Mr. Frank King, who has been appointed managing engineer, in tracing the cause and remedying the defects in the plant. Some of the improvements suggested and carried out by Mr. King were not completed very early in the year 1892, and we are therefore warranted in looking for better results at the end of the year. With the experience gained we do not doubt that further economies can be made. As you will have seen in the report, the amount paid for coal in 1892 is 9½ per cent. less than that paid for coal in 1891, although the amount of electricity sold is 23 per cent. more in 1892 than in the previous year. Not only has there been a saving in coal, but there has been greater economy all along the line. The cost of coal, water and engine room stores taken together has been 1d. less per unit of electricity sold, and the total cost of the unit, including all general charges, has been 1½d. per unit less than in 1891. You will expect to hear something from me regarding the decision in the law courts on the three-wire system. In Chelsea our supply is on two wires only, and in the small portion of South Kensington served by this company the system is such that it is our belief that we cannot be brought under the operation of Mr. Hopkinson's patent. The proposed transfer of the Kensington portion of our area was the cause of the extraordinary general meeting held on the 14th ult., when the policy of the directors in regard to that matter was unanimously approved. As stated at the meeting, the directors consider that the transfer will be beneficial to both companies, owing to the position of the two generating stations relatively to the area. The price agreed upon is a fair one, and the capital thus set free will be of material assistance in extensions in our Chelsea area, so as to cope with the demands arising in the immediate future. The prospects of the company are now better than ever, both as regards profits and increase of business. The district in which our mains are laid is rapidly filling up with customers, and no one, when once supplied by our system, cares to discontinue its use. Close around us new houses are everywhere being built, and I am informed that in many of them no provision is made for gas. Such is the confidence earned by careful attention to the quality of the supply. Residents who have tried several systems say that none is better than that of our company. We cannot stand still, but must be always moving forward, using strict economy as to the direction in which the capital is spent, and continuing to make such additions and improvements in plant as will ensure the largest saving in the everyday work of supply. We have a good future before us, if we succeed in making judicious use of our opportunities, and I hope that our endeavours will meet with cordial support from our shareholders. I now move "That the report of the directors and the statement of accounts to December 31st, 1892, now before the meeting, be and they are hereby adopted, and that the payment of a dividend for the year ending December 31st, 1892, at the rate of 2½ per cent. per annum on the ordinary share capital of the company be and is hereby approved, to be made payable on April 15th."

Major-Gen. Webber, C.B., seconded the motion, and said he could fully endorse all the chairman had said as to the benefits they were likely to derive in the future from the improvements effected in the working.

The resolution was then carried.

The Chairman proposed, Mr. Gillings seconded, and it was resolved, that the two retiring directors, Sir George Prescott, Bart., and Mr. E. Garcke be re-elected, and a similar vote was carried with reference to Messrs. Cooper Bros. & Co., the auditors.

The meeting was then made special, when the resolution passed at the extraordinary general meeting held on February 14th, approving the bill for the transfer of a portion of the company's system to the Kensington and Knightsbridge Electric Lighting Company, was confirmed.

A vote of thanks to the chairman and directors closed the proceedings.

The Birmingham Electric Supply Company.

The following is the third annual report of the directors:—The amount of net profit, including the balance of £361 19s. 9d. carried forward last year, is £3,850 2s. 7d.; out of this the directors recommend the payment of a dividend of 3½ per cent., absorbing £2,056 11s. 11d., placing £1,279 9s. to the credit of the depreciation reserve fund, and a further sum of £250 towards a general reserve fund, and carrying forward the balance, £264 1s. 8d., to next year's account. The capital expenditure during the year amounts to £9,868 3s. 2d., and includes the complete equipment of the present boiler house by the addition of three new boilers, the provision of two further engines and dynamos, and the extension of the company's services. The total number of 16 C.P. lamps or their equivalent on order on December 31st, 1891, was 5,480, and on the same date in 1892 the number was 8,329. The demand for the light still continues, and the additions since the close of the financial year brings the total number up to 9,142. The frequent application for the light outside the company's area induced the board last year to look in what direction it might be advisable to extend the company's system, and after careful consideration, it was resolved to take the preliminary steps necessary to obtain Parliamentary powers over the district of Edgbaston, and what is known as the jewellers' quarter. Accordingly a deputation of the board approached the corporation, in order to obtain their assent to these extensions. For reasons, however, with which your board did not agree, the corporation desired that the application should be postponed for a year; but, having regard to the uniformly courteous consideration extended by the corporation and its officials to the company, it was decided not then to press the matter. Your board, however, feel that the claims of the public, and interest of the shareholders, alike demand that the question should not be further delayed, and at the proper time steps necessary to renew the application during the current year will be taken. Two directors, Mr. George S. Albright and Mr. F. W. V. Mitchell retire, and, being eligible, offer themselves for re-election. The auditors, Messrs. Sharp, Parsons and Co., also retire, and, being eligible, offer themselves for re-election.

Telegraph Construction and Maintenance Company, Limited.

The twenty-ninth ordinary general meeting of the above company was held on Tuesday last, at the offices of the company, 38, Old Broad Street, E.C., Sir George Elliot, Bart., presiding.

The managing director (Mr. Wm. Shuter) read the notice convening the meeting, also the minutes of the two previous meetings.

The report was taken as read, and the Chairman said he was not going to make a long story. He would just place before them a few particulars. He then read his speech as follows: "I daresay that part of the report which deals with the reduction in the dividend which we have been able to pay with unusual regularity for many years has most attracted the attention of some of the shareholders, but while we sympathise with you in these circumstances, there is nothing, I think, to cause surprise or uneasiness. It is mainly due to the exceptional year we have passed through as regards cable operations, no large works having been undertaken. It is also in part due to a falling off in our general business. The cause of both, I think, is not far to seek, that is to say, the general depression which has affected trade in all its branches, from the highest to the lowest; but which there is no reason to believe, so far as we are able to judge, will be of a permanent character. There is work on hand at present, and we hope there is more in prospect during the year, and for this the company has considerable stock laid in. We have taken advantage of a comparatively slack time to introduce improvements into our plant and appliances at both our factories, all tending to increase their capacity for work, and in the direc-

tion of economical expenditure." He then formally moved that the report and accounts of the directors to December 31st, 1892, submitted to this meeting, be received and adopted, and that a dividend of 24s. per share, in addition to 12s. per share interest, or interim dividend, paid on June 30th, 1892, be paid upon all the shares of the company and that such dividend be paid free of income tax.

Mr. GEO. W. CAMPBELL seconded the resolution, which was carried unanimously.

Mr. James Pender and Sir Robert G. W. Herbert, G.C.B., were re-elected directors of the company.

The auditors, Messrs. John Gane and Patrick A. Glegg were also re-elected, and a vote of thanks to the chairman and directors having been acknowledged by Sir George Elliot, the meeting closed.

Liverpool Electric Supply Company, Limited.

THE tenth annual meeting of this company was held last Friday, at Exchange Buildings, Liverpool. Mr. A. H. Holme presided.

The CHAIRMAN, in moving the adoption of the report and balance-sheet, said that the directors were offering the 5 per cent. dividend in addition to writing off £4,099 for depreciation and putting £2,000 to the renewal fund. They did not propose to give sensational dividends, which probably might cause them to come down to 3 or 4 per cent., but to go on steadily at the rate they could afford. Regarding the mains, he remarked that there was a good deal of misunderstanding. The amount written off for depreciation was quite sufficient, because the copper in the mains would practically last for ever. The company were in such a position that it was absolutely necessary to extend so as to meet public demands; indeed, they were obliged under a penalty to supply additional mains, machinery, more powerful engines, and larger dynamos. Mentioning the difficulty the company had had with local authorities in extending their areas, he said that individually members and officials were very good to them and anxious to help them, but when they got into collective form in committee they seemed to regard them as natural enemies. He was happy to say that lately the Corporation had treated them better, and they had now got permission to lay their mains to Sefton Park, and arrangements had nearly been completed with the Toxteth Park Local Board for laying mains in that district. The electric light had also been introduced to the ball-room of the Town Hall, though the rest of the building remained in comparative darkness. He congratulated the shareholders on the fact that, in addition to having secured a very fair dividend, the introduction of the electric light into banks and places where many clerks were employed had resulted in much good, the clerks having since then had very much better health. One gentleman, in fact, had told him (the chairman) that he would not be without the electric light for thrice the amount he paid for it. As to the price of the supply, the chairman remarked that when certain patents ran out it would become very much cheaper.

Mr. LISTER, as a director of the Liverpool Gas Company, remarked that there was a feeling of thankfulness to the Electric Supply Company for having educated the people up to the requirement of better light, so that more gas was being used than formerly.

Mr. A. B. HOLMES, the managing director, indicated several purposes additional to that of lighting for which the electric supply was being demanded by the public and would be asked for in future.

Sir DAVID RADCLIFFE seconded the motion, which was carried unanimously.

On the motion of Mr. LISTER, the remuneration of the directors was increased to 750 guineas.

Mr. J. S. Harmood Banner and Sir David Radcliffe were re-elected directors.

Formal authority for increasing the capital as stated was given, and the proceedings closed with a vote of thanks to the chairman.

The Cambridge Electric Supply Company, Limited.

THE first report of the directors will be submitted at the general meeting of the company to be held to-day, March 3rd, 1893, in which it is stated that the deed of transfer of the Cambridge Electric Lighting Order, 1890, by the Corporation to the company, was completed on December 13th, 1892. The number of shares issued up to the present time is 1,836. A site in Thompson's Lane was adopted for the generating station, and the works were commenced at the end of July, 1892. The supply of electric energy to consumers was begun on November 19th, 1892, at which time the number of lamps in electric connection with the station was equivalent to 230 10-candle-power lamps. The number of lamps connected at the present time is equivalent to 4,700, and the number actually applied for to 6,200 similar lamps. Two steam boilers, one steam superheater, one economiser, and three turbine-alternator dynamos, each capable of supplying current for 3,500 10-C.P. lamps at the same time, and all other requisites for a complete central station have been set up. A length of five miles of double cable has been laid down in iron pipes in the streets, and seven colleges have the mains in their courts and become consumers of the current. The engine room, boiler house, and chimney shaft at the station, have been built in a good substantial manner. The engine room and shaft are large enough for the supply of 30,000 lamps. A strong river-wall, consisting of iron piles, 30 feet long, and 4 feet apart, with timbering between, is in course of construction, and will be completed in a few days. The directors deemed it expedient that the company should themselves undertake the wiring of houses and buildings and the supply of fittings, at all events for a time, and a considerable amount of this work has been executed by the company. The prices charged have been made as low as possible, consistent with securing a moderate profit, which has been realised. The total expenditure incurred up to the present time amounts to about £22,000, and a considerable further expenditure will be required for some time to come. The demand for current from the outset of the company's operations has been much greater than the directors anticipated, and a considerable extension of the company's mains and works is, and will be, necessary to fulfil the present and future requirements of consumers. The directors propose for these reasons to make a further issue of £10 shares, on which it is intended to call up not more than £8 per share. £2 per share will be payable on application, and a further £2 on allotment, and the remaining two calls at intervals of not less than two months. Any applicant may, if he thinks fit, pay up at once the full amount of £8 per share. The amounts paid for these shares will rank for dividend on an equal footing with the other shares of the company, but from the respective times only when the several amounts are paid, and in proportion to such amounts.

Sir Benjamin C. Browne and Mr. D. Munsey retire. Both of them offer themselves for re-election.

The directors are gratified with the success which the enterprise has met with in Cambridge, and they regard the position of the company as most satisfactory and encouraging.

Northampton Electric Light Company.

THE fourth annual meeting of the shareholders of the Northampton Electric Light and Power Company, Limited, was held at the Town Hall on Friday last. The directors reported that the business of the company continued to increase, and the electric light was steadily making its way. At the present time there are more than 4,000 8-C.P. lamps, or their equivalents, connected with the company's mains, and not a few of the original customers have shown their appreciation of the light by extending its use. The debentures referred to in the last report, amounting to £5,000, had all been taken up, and the interest upon them had been punctually paid. After providing for debenture interest, there is a balance of profit this year of £87 15s. 1d., which will go in reduction of the deficiency occasioned last year by working expenses having been incurred for some months before the accession of customers. The third engine-set will be shortly in working order. To meet the additional cost it has been resolved to issue 6 per cent. cumulative preference shares to the extent of £5,000. These shares had been allotted to the extent of £3,180. The directors had been fortunate in securing some property adjoining the company's works in Angel Lane for the erection of coal sheds, which would result in a substantial saving in the way of cartage, and there will be abundant room for any future extension of the works. The chief engineer, Mr. B. R. Beale, had given up his position, but most kindly continues to devote a considerable amount of time and energy to the promotion of the company's interests. He was succeeded by the second engineer, Mr. W. E. Heenan. The report was adopted, and Messrs. Seckham and Manfield, the retiring directors, were re-elected.

Keswick Electric Lighting Company.—The annual report of the Keswick Electric Light Company has just been issued, and the directors recommend the payment of a dividend of 2 per cent. The past year, like its predecessors, has been prolific of difficulties. A new boiler has been provided, and the working of the station has, owing to insufficient water power, been dependent more largely upon steam as an auxiliary than it is expected to be in the future. This accounts for the increase in working expenses, and consequent diminution of profits. The addition to expenditure, amounting to £966, includes cost of new boiler, extension of main wiring to Vicarage Hill, &c., and other expenses cast upon the company by Board of Trade regulations. The benefit of this outlay has not been felt to its full extent, but the business has been increased since last year in the proportion of 791 to 949 lights.

Compagnie Française du Bimetal.—This company has for its object the manufacture of so-called "bi-metallic" wires for electric purposes under the patents of Edouard Martin. Its capital is 1,300,000 francs in 2,600 shares. The company will have the use of M. Martin's patents in France, but his foreign patents remain his exclusive property. The company will have the benefit of the agreements entered into with the Oberschlesische Eisen-Industrié Actien-Gesellschaft at Gleinitz, which is not, as the *Industrie Electrique* states, in Austria, but in Prussian Silesia.

Hermite Company.—The shareholders of the French company for carrying out the Hermite processes (electric manufacturers of alkali and bleach) hold their general meeting at Paris on March 22nd.

Madrid Electric Company.—The general annual meeting of the Madrid Electric Company will be held at Madrid on March 16th.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the wee ending February 26th, 1893, amounted to £943; week ending February 28th, 1892, £834; increase £109; total receipts for half-year, 1893, £7,743 corresponding period, 1892, £6,739; increase £1,004.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of February were £3,700; as compared with £3,643 in the corresponding month of last year.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 24th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,232.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, February 23rd.	Closing Quotation March 2nd.	Business done during week ended March 2nd, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	100 —103	100½	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	53½ — 54½	53½ — 54½	54⅛	53⅞
2,876,140*l*	Do. do. 6 p.c. Preferred	Stock	94½ — 95½	94½ — 95½	95½	94½
2,876,140*l*	Do. do. Deferred	Stock	13½ — 14	13½ — 13⅝	13⅝	13⅜
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12	12 — 12½	12⅜	12
34,600*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	105 —109	105 —109	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3¼ — 3½	3⅛ — 3⅜xd	3 7/16	3 3/16
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2¼ — 2½	2⅛ — 2⅜xd	2⅜	2 3/16
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	105 —107	103 —105 xd	104½	103½
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
600,000*l*	City and South London Railway	Stock	35 — 37	35 — 37	37	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	12½ — 13	12½ — 13	12 5/8	12⅝
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	8¼ — 8⅜	8¼ — 8⅜	8⅜	8⅜
$7,716,000	Commercial Cable, Capital Stock	$100	175 — 180	175 —180	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16 — 5/16	3/16 — 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5 — 5½	5 — 5½	5⅜	5¼
16,000	Cuba Telegraph, Limited	10	12 — 13	11½ — 12½xd	...	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	17½ — 18½xd	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 12	11⅜ — 12	12	11 13/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜ — 15⅛	14⅜ — 15⅛	15 1/16	14⅜
70,000	Do. 6 p. c. Preference	10	15⅞ — 16⅛	15⅞ — 16⅛	15 1/16	15 1/16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	112 —115	113 —116	114⅜	114
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅛ — 15⅜	15⅛ — 15½	15 7/16	15⅜
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	110 —113	110 —113	...	...
122,400*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3⅜ — 4¼	3⅜ — 4¼	3⅞	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛ — ¼	¼ — ½	...	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛ — ¼	⅛ — ⅛	⅛	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	¼ — ½	¼ — ½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	1½ — 2½	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝ — 9⅞	9⅝ — 9⅞	9⅞	9 11/16
180,042	Do. do. 6 p. c. Preference	10	15⅛ — 15⅜	15¼ — 15⅜	15½	15¼
150,000	Great Northern Tel. Company of Copenhagen	10	19 — 19½	19 —19½	...	...
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	104 —107 xd	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6½ — 7½	6½ — 7½	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	23 — 24	22 — 23 xd	23	22⅝
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	104 —106	105	...
17,000	Indo-European Telegraph, Limited	25	43 — 45	43 — 45	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4½ — 4⅝	4½ — 4⅝	4⅝	4 7/16
10,000	Do. do. fully paid	5	5⅞ — 6	5⅞ — 6	5⅞	...
38,348	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 —111	105 —108 xd	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6 — 6½	5⅞ — 6¼	6⅛	...
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	...	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	5¼ — 5½	5⅛ — 5⅜	5⅜	5¼
15,000	Do. 6 p. c. Cum., 1st Preference	10	14½ — 15½	14½ — 15½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13¾ — 14¾	13¾ — 14¼	14¼	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	4⅜ — 4⅝	4⅜ — 4⅝	4 9/16	4½
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 —116	113 —116	114⅛	114⅛
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5½ — 6½	5½ — 6½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛ — ¼	⅛ — ¼	...	...
11,802	Reuter's Limited	8	7½ — 8½	7½ — 8½	7 9/16	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8 — 8½	7¾ — 8¼	8¼	8 3/16
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8	...
3,381	Submarine Cables Trust	Cert.	118 —123	119 —124	121	120
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3½	3 — 3½	3¼	3 1/16
37,350	Telegraph Construction and Maintenance, Limited	12	37 — 40	35 — 38	37½	35
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2½ — 3	2½ — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ — 7½	6½ — 7½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	102 —105	100 —103 xd	...	...
30,000	West Coast of America Telegraph, Limited	10	2½ — 3½	2½ — 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	104 —108	104 —108	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7⅜ — 8¼	7⅜ — 8¼	8	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5⅜ — 6¼	5⅜ — 6¼	...	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1⅜ — 2¼	2 — 2⅜	...	...
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —108	105 —108	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	106	...
88,321	West India and Panama Telegraph, Limited	10	1½ — 1⅝	1½ — 1⅝	1 11/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10⅜ — 11¼	10⅜ — 11¼	11 1/16	10 13/16
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	107 —110	107 —110	109½	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
171,000*l*	Do. do. 6 p. c. Sterling Bonds	100	103 —106	101 —104 xd	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½ — 6	5½ — 6 xd	5⅞	5¾

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. Bank rate of discount, 2½ per cent. (January 26th, 1893.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1⅞—2⅛.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5⅛.—Elmore Foreign and Colonial Copper, Founders shares, 6⅞—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 1½—2½.—Do. 7 per cent. Preference of £5, 5—5½.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5½, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6⅛.—Liverpool Electric Supply Shares of £5 (fully paid), 5⅞—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Debentures, 101—103.—Woodhouse and Rawson £5 Preference (fully paid), ⅞—1½.

‡ Unless otherwise stated all shares are fully paid.

HEATING EFFECTS OF ALTERNATING CURRENTS.*

BY A. D. LUNT.

IN an article on the "Alternating Current Ampère" in the *Electrical World* of January 7th, the definition of an alternating current is given in terms of its heating effects, this being thought simpler than by defining it as the square root of the mean square of the current strength. To quote from the article in question: "The ampèrage of an alternating current is equal to that of a constant current when the heating effects of the two currents passing through equivalent resistances are the same. If the resistance is constant and non-inductive, the heating effect measures the whole energy expended, and is proportional to the square of the current, and when the latter is constant is very easily calculated." While, as a matter of fact, this ease of calculation is true in the case of continuous currents, the aspect of the case changes when we come to deal with alternating currents, and we cannot even take the resistance of the conductor the same as for continuous currents. This point may be illustrated by some experiments suggested by Dr. Bedell, of Cornell University.

It is well known and has been investigated mathematically, that the resistance of a conductor to alternating currents is greater than to direct currents of the same value, and this is well shown by the accompanying curves, which were obtained from a hot wire ammeter by passing direct and alternating currents through the instrument and noting the corresponding readings. The abscissæ of the two curves of fig. 1 represent current in ampères, while the ordinates

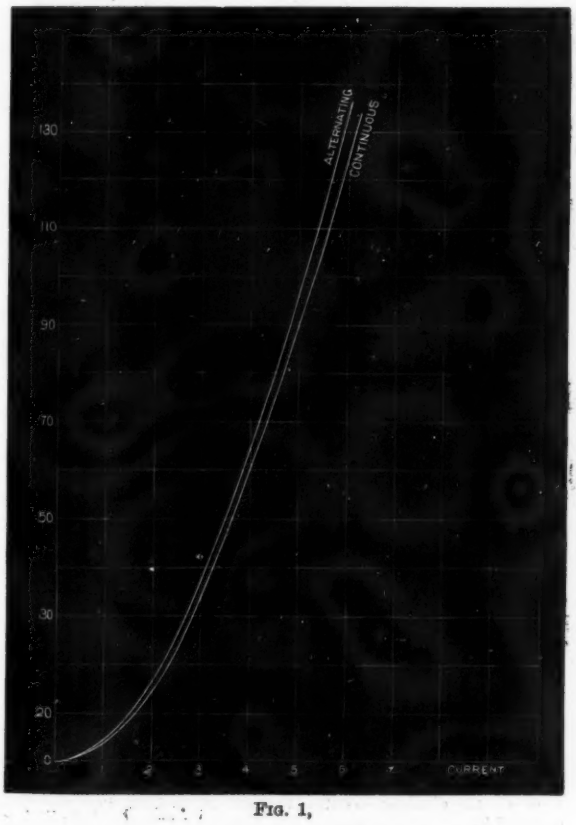


FIG. 1,

represent heating effects which are measured in this case by the elongation of the heated wire. The upper curve is that due to alternating currents, and the lower curve represents the effects due to continuous currents of equivalent values as measured by a Thomson balance.

It will be noticed that for any given current the elongation of the wire and consequently the heating effects are greater for alternating than for direct currents, and that this difference is not a constant quantity, but varies with the current; so that if we say that a continuous current passing through a resistance is equal to an alternating current which produces the same heating effects in another conductor of equivalent resistance, we state a fact which is literally true, but which involves the question as to what the equivalent resistance may be in this case.

As a further illustration may be mentioned some calorimeter experiments performed by Messrs. Hale, Kelley and Hall under the direction of Dr. Bedell.

The use of the calorimeter is simply another way of attacking the problem, and in brief is as follows: A continuous current with a certain constant value is sent through a coil of platinum wire inclosed in a water calorimeter, and the rise in temperature of the water after certain intervals of time is accurately measured. This operation is continued until a sufficient number of readings have been taken, and the calorimeter is then allowed to cool off. A new start is then made with an alternating current of the same value as measured by a Thomson balance, readings being taken as before, and the current being kept at a contant value by means of a water rheostat, as was done in the first case.

The curves of heating thus obtained are shown by the solid curves in fig. 2, in which the abscissæ represent time

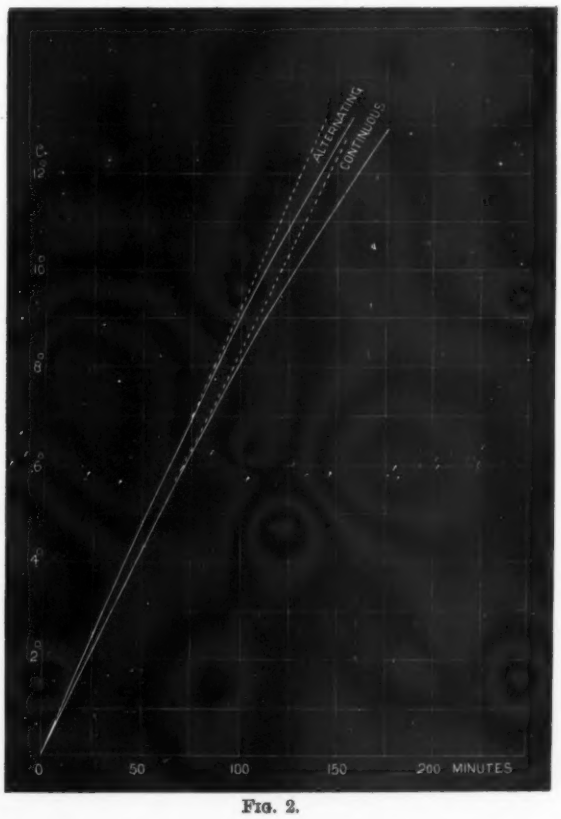


FIG. 2.

measured from the moment of turning on the current, while the ordinates represent the corresponding temperatures in the calorimeter.

In order to correct for the heat radiation from the calorimeter a so-called cooling curve (not given here) was obtained, in which the rates of cooling at different temperatures were shown. Combining this curve with the curves of heating, we obtain curves showing the rate of heating if there were no radiation or loss of heat. The change in resistance due to temperature, being but a small portion of one per cent., may practically be neglected, so that we have as a result the dotted curves in fig. 2. These are practically straight lines and represent the rate of expenditure of electric energy in heating the conductor. Since the expenditure of electric energy is proportional to the product of the square of the current and the resistance, and since the square of the current strength is the same for each curve whether the current be alternating or continuous, the rate of transformation of electric energy into heat must in each case be proportional to the resistance of the wire in the calori-

* New York *Electrical World*.

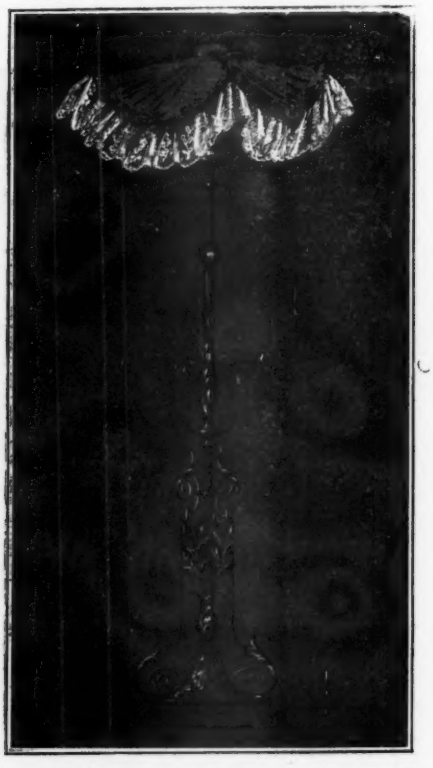
meter. The change in resistance must consequently be represented by the difference in the slope of the two lines.

The per cent. increase in resistance of the wire to the alternating current is conveniently shown by the ratio of the difference of two ordinates to the smaller ordinate, which in this case represents the resistance of the wire to the continuous current; the two ordiñates taken should, of course, have the same abscissa. For this particular case the increase in resistance amounts to approximately 10 per cent.

These experiments, while only the beginning of an investigation, serve quite well to show the complicated nature of the changes in resistance which a conductor undergoes when traversed by an alternating current, and the matter becomes still more involved when different periodicities are used. Under these circumstances it does not seem advisable, except for the sake of illustration, to define an alternating current according to its heating effects.

LIGHTING OF THE CERCLE DE LUXE.

In the fitting up and furnishing of the rooms of the newest club no expense has been spared, and in each department the work has been executed by firms of the highest reputation. The electric fittings supplied by Messrs. B. Verity & Sons are said to surpass anything of the kind hitherto produced. We give an illustration of the electroliers in the smoking



room, which were specially designed to harmonise with the Elizabethan style of the decoration. Each arm of the electrolier terminates in a dragon's head of a rich gold colour, and expanded wings finished in silver, with a pendant lamp on each side. There are eight lights in each electrolier, and when lighted it is exceedingly brilliant and ornamental. The ladies' drawing-room on the first floor is lighted partly by three-light brackets in the corners of the walls about 12 feet from the floor, and also by six handsome floor lamps richly chased and gilt of a special design to correspond with the furniture. The large dining room is lighted by brackets in the old French style, the lamps being enclosed in light yellow silk coverings. In the private dining rooms five-light electroliers are used, the light being thrown down by means of silk shades.

A CENTRAL STATION AT BRÜNN.

[From our own correspondent.]

At a recent meeting of the Common Council, Dr. Koretz spoke as follows concerning the erection of a central electric station. A project had been submitted by a person desirous of tendering. But he had come to the conclusion that an electric central station simply for the supply of light must be an unprofitable undertaking, as the want of the electric light was not uniform, and as night work had been wholly or partially abandoned in most of the manufactories in Brünn. On the other hand, also, the larger establishments produce electric light for their own use. As regards the existing gas agreement, public electric lighting would be considerably more costly than the present gas light. A central station would be remunerative here only if the undertaking would include also the transfer of power for industrial and commercial purposes. But even then, in order to obtain satisfactory results, the use of electric power must prove decidedly cheaper than steam power. Nothing further has been heard for some months from the projector—a Vienna company who have made a very thorough study of the question. A Brünn firm, who had also made inquiries concerning the erection of an electric central station, expressed themselves verbally to the burgomaster to the effect that such an undertaking could be remunerative only if the current was in general use at Brünn in place of steam-power. In this case electric-power would come 40 to 50 per cent. cheaper than steam-power (?).

It is the part of technicists to examine whether these proposals are financially practicable. The burgomaster had made the remark that, in his opinion, the time for the erection of an electric central station at Brünn has not yet come (! ?)

Klaer remarked that the supply of cheap power for the motors of small industrialists was of vital importance for the latter, and thought that if the representatives of the community did not themselves undertake the construction of an electric central station but would merely show goodwill to the project, the question would be solved within a moderate time.

Burgomaster Winterholler explained that there was no idea of erecting a central station on the part of the community, but it would place no hindrance in the way of private under-

takings. But if projectors required an agreement for 60 years, the community must reflect well before concluding such an agreement.

The engineer, Petritsch, characterised the erection of an electric station for the supply of light and power as a want very extensively felt with which the interests of the community appeared connected. Sooner or later the community must take up this question, as they are themselves consumers of electric light in the town theatre, and further purpose introducing it into the Emperor Franz-Josef Provident Institution. The calculations of the persons tendering did not seem to him conclusive, and he expressed his conviction that if the community took in hand the erection of an electric central station, it would prove a remunerative undertaking. Against the erection of a central station there has been urged the dislike to an agreement with a private undertaking, and as a second motive, that electric lighting was still in its childhood. Neither argument was valid. In proof, the speaker brought forward the electric central stations at Vienna, Paris, London, Berlin and Rome, as well as the decisions on this subject by the municipalities of Karlsbad and Gräz, and declared that it was time for Brünn to think seriously on the erection of an electric central station. Finally, the speaker moved, amidst applause, that the question be referred for investigation and report to the department of works.

Burgomaster Winterholler remarked that the Vienna undertaking mentioned in his communication had made very careful investigations and had thoroughly studied the figures produced. As regards the introduction of a supply of electric power, it must be considered that it would involve a further displacement of human labour.—*Tagesboten (aus Mähren und Schlesien).*

HAMBURG ELECTRIC LIGHTING.

[FROM OUR OWN CORRESPONDENT.]

ON February 14th, a pamphlet with the motto, "More Light," was addressed to the members of the municipality, in opposition to the proposed agreement with the firm, Schuckert & Company, and recommending the tenders of the firm, Siemens & Halske, or of the Allgemeine Electricitäts Gesellschaft.

The pamphlet has been avowedly written without the knowledge of the two latter firms, who have both declared that they will not mix themselves up with the present stage of the question.

Nevertheless, the contents deserve attention, and the municipality has cause to feel grateful to the unknown author for his hints. In one point only I should wish to supplement them. The continuous current project of Siemens & Halske, which the pamphlet takes as the basis of its exposition, and correctly remarks that it is the only pure continuous current project, is the only one of several which the Berlin firms have considered and were prepared to submit to the local authorities for selection.

The Berlin firms who jointly have installed half a million lamps in about 60 capitals of the world would in every case use the system most suitable for local conditions. Among the centrals at present in course of erection, one (Bremen) is a pure continuous current installation; two (Cape Town and Dresden) are alternating current works; and the last, which supplies the entire Taunus region from Hamburg to Königstein, is a rotatory current installation. This seems to me the advantage of firms which have the greatest command of capital that they are strangers to one-sidedness and can at once render every advance of science and technics available for their clients.

Exactly from this point of view, and fully aware that the decision for one or other of the competing systems can be effected rationally only with a full knowledge of the demand for current and of its local distribution, the above-named Berlin firms expressed themselves to the finance deputation to the following effect:—

January 2nd, 1892.

"In how far the direct multiple lead system can be brought into use in the districts 4 and 5, in view of their spacial extent and the small density of consumption, as well as in the adjoining districts, must be left for future consideration.

"We have elaborated several projects in order to satisfy ourselves that on undertaking the duty of supplying districts 4 and 5 with current *within the stipulated time*, we may not encounter difficulties which would either compromise the economical result or the unitary execution of the undertaking, but we would, with reference to the more remote time of the completion and the experience to be obtained in the interval, the less bind ourselves to the choice of a definite system as we should, both in the choice of the system and in the erection of the new work, always take into account the wishes of the superior authorities."

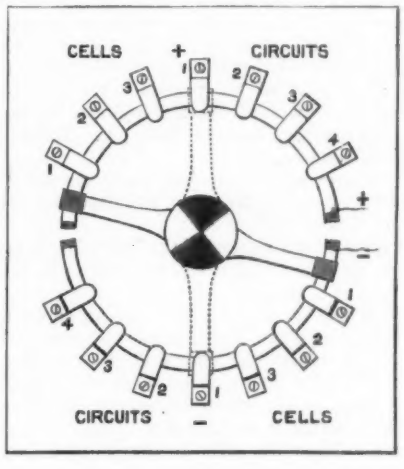
The stipulated delay was in my opinion fixed more precisely in the tender of Siemens & Halske than that in the agreement now awaiting approval.

The course of the last weeks has proved to the public of Hamburg how rational is this representation, and it is therefore infinitely to be regretted that a few days after they were received, the decision was made by the authorities between Schuckert & Company and Siemens & Halske, in favour of the former firm on purely technical grounds, without examining any one of the elaborated projects. The decision has been made by the committee because the Berlin firm, in the document above cited, founded their tender in principle on the totality of the districts, but reserved the decision when and how the supply of the suburbs was to be carried out; and because, if "the project were accepted there is no certainty within what time and in what manner the suburbs can be included within the scope of the electric supply."

It is to be deplored that the disregard of the words in the tender, "within the stipulated time," has excluded the most important firms from the competition. The alleged technical defects have been the sole cause why these firms have been defeated in the competition.

A NEW DOUBLE-POLE VOLTMETER SWITCH.

THE accompanying sketch shows a very simple, easily constructed, and convenient double-pole voltmeter switch for use in central stations, and designed by Mr. Malcolm Sutherland. It consists of a split brass ring, a number of brass clips or contact pieces, and an arm made of insulating material and having at each end brass contact pieces,



and a handle in the centre for turning it. The number of clips depends on the number of points at which it is required to read the potential. The illustration shows one which was made to read the potential of three sets of accumulators and four circuits. The wires from the voltmeter are connected one to each half of the ring, and the wires from the cells and circuits are brought to the clips ranged round the outside of the ring. The clips are clear of the ring so long as the

arm is in the position shown in the sketch, and the voltmeter is therefore entirely disconnected from the cells and circuits. When it is necessary to take a reading on any of the circuits all that has to be done is to turn the handle so as to bring the brass contact pieces between the clips and the ring. Thus the dotted line shows the arm in position for taking a reading from circuit No. 1.

THE HISTORY OF LIQUID INSULATORS.*

By A. M. TANNER.

The insulating properties of oils were utilised by Jean in 1858 for insulating induction coils or transformers,† and in the year 1859 Prof. Hughes (the inventor of the microphone), proposed to maintain the insulation of underground cables, even after the disintegration of the gutta-percha, by placing the cable in a tube filled with a semi-fluid composition, which would filter into the fissures in the gutta-percha if any were made in course of time.

Jean employed, in preference, spirit of turpentine, in which he immersed the induction coil or transformer, whereas Hughes recommends specially the employment of a semi-fluid substance, such as gutta-percha combined with oil or resin dissolved in oil or spirit of turpentine.

The application of an insulating fluid to the supports of electrical conductors was proposed for the first time in a French patent taken out by Lenoir and Prud'homme, No. 36,216, dated June 24th, 1869.

These insulators are now generally used in the high tension system for the transmission of electrical energy, and the invention of them is generally attributed, in England, to Johnson & Phillips. It will therefore be interesting to reproduce the text of Lenoir and Prud'homme's patent, and the drawing accompanying this patent, with the object of proving that as early as 1869 the idea was conceived of "constructing insulators containing an insulating fluid placed between the line and the earth," which idea is claimed in the French patent taken out by Johnson & Phillips, November 7th, 1876, No. 115,363.

Copy of the 15 years patent taken out by Messieurs Lenoir (Jean, Joseph, Etienne) and Prud'homme (Pierre Désiré), at Paris, Rue Saint Martin, No. 4 bis (No. 36,216), Dated June 24th, 1869, for an insulating support for telegraph wires.

"*Description.*—Our invention consists in the arrangement of two pieces of porcelain or other insulating material placed one upon another so as to form an inner chamber of air without letting the external circumference of the pieces of porcelain touch; the form of the porcelain prevents the water driven along by the wind from making the interior of the chamber of air damp, and also excludes fog. It thus prevents leakages along the line.

"The arrangement we have just briefly described will be clearly understood upon examining the drawings annexed to the claims of the patent.

"Fig. 1 represents a section of the insulating support, A is the cap or upper part; B, a half-sphere fitting into the groove, F, of the part A; E, E, the chamber of air; C, an iron support which sustains the insulating system on the pole, and is sealed in the middle. Fig. 2 shows the support mounted on the pole. To show the effects of the exclusion of the air and those of the air chamber, we have coloured red the imprisoned mass of air which represents the part which is constantly dry for the insulation of the line.

"*Working.*—When the outer air driven by a storm tends to penetrate into the inner chamber, E, E, it compresses the air contained in this chamber, but cannot mix with it, as the inner air cannot be put in vibration, the column of outer air not being able to overcome the obstacle opposed to it by the arrangement of the two portions, A and B. It must enter at F to descend into the chamber E.

"Water cannot enter, for driven by the wind it dashes against the portion B, and can only flow round the edges of the cup and fall back down the pole. *We can also put in the air chamber an insulating liquid which would form a liquid excluder.*

"It will be seen by the above that what we wish to patent is the arrangement of one or more pieces of insulating material arranged so that they form one or several air

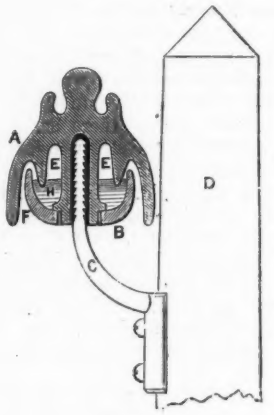


Fig. 1.

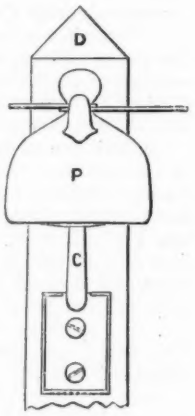


Fig. 2.

chambers into which the outer air and water cannot penetrate, because in order to penetrate it would have to ascend at F, and then descend into the chamber E, which it can only do by compressing the air of the inner chamber, and the density of the outer column of air can never vary sufficiently to overcome this obstacle."

A little while after the above patent was taken out, Messrs. Simond and Gould obtained a French patent dated July 25th, 1869, No. 86,582, for an insulator for telegraph wires, the construction of which may be seen in the drawing (fig. 3).

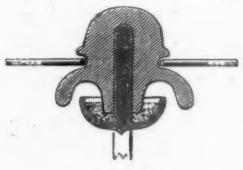


Fig. 3.

It is not stated in this last patent, although it is to be found in W. E. Simond's earlier American patent dated June 27th, 1869, No. 92,111, that the insulating material placed in the cup forming the lower portion of the insulator was supposed to remain constantly in a liquid state as indicated in Lenoir and Prud'homme's patent.

In fact, it is simply stated that the cup is filled with any non-conducting substance, paraffin, for instance. The word, "liquid" is never used in the description, and, of course, the

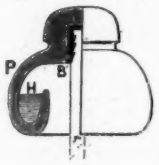


Fig. 4.

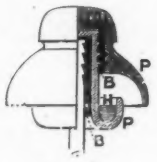


Fig. 5.

melted paraffin introduced into the cup becomes solid. But, on the contrary, in Lenoir and Prud'homme's patent, we find expressly mentioned "a liquid insulator forming a liquid excluder (fermeture)."

The oil insulators of Messrs. Johnson & Phillips are well known in commerce; it may, however, be worth while to reproduce the drawings accompanying their French patent of November 7th, 1876, No, 115,363 (figs. 4 and 5). This patent states that "the cup is filled with any insulating

* *L'Industrie Electrique.*

† See *L'Industrie Electrique* for February 25th, 1892, p. 83.

fluid whatever, preferably a hydro-carburet, which will not bear on its surface either moisture or dust.

From the above examination of inventions of French, American and English patents, made in the interests of truth and justice, it follows that French inventors were the first to propose the employment of insulating liquids in supports constructed specially for electric wires.

THE SPECIFICATION OF ELECTRIC PLANT AND MAINS FOR OPEN COMPETITION.

By THOMAS TOMLINSON, B.E., Assoc.M.Inst.C.E.

It may be useful, at this time, when every week sees some new scheme, to try and arrive at some idea of the general form of specification calculated to result in the best possible value being obtained for the money spent; the attainment of which I take to be the object of any specification.

The most natural plan is to begin by negative criticism of certain bad forms.

Of these the most common, and, I believe, by far the worst, is that which states the number of lamps to be provided for, and requests information as to the advantages of the system proposed; and which is accompanied by a plan of the district with the roads to be supplied, tinted, and the position of one or two possible sites for the central station marked.

This is usually the work of a municipal board or committee which has got an order and decides to ascertain what a scheme will cost, and, bent on economy, resolves to get its consulting engineering for nothing.

When the tenders are opened the members of the board or committee find they have before them specimens of every form of electrical generation and distribution under the sun, each accompanied, as desired, by an account of its advantages over all the others.

Now, as it is not given to mortal man to weigh, with any approach to accuracy, the value of *ex parte* statements in a science of which he knows nothing, the wisest thing is to call in an expert to adjudicate. He will very likely advise the rejection of all the tenders (for sound reasons to be given subsequently in this article), whereat the committee will be very angry at the loss of time, and the absurd position in which they are placed; the contractors (especially the lowest tenderer) will be furious, and will consider themselves very badly used. The opposition will probably work an indignation meeting of ratepayers, at which very hard things will be said as to the experimental character of electrical engineering at present; and, as the committee will be partly of the same opinion, the chances are that the whole thing will be adjourned *sine die*.

If the members of the committee decide to adjudicate unaided, it is pretty certain they will decide on the one thing they understand—lowness of price.

Now lowness of price is only one factor of value, and by deciding on it alone, they run a grave risk of making a bad bargain; this risk will be much increased when it becomes generally recognised (as it certainly will, sooner or later,) that the one thing to do in preparing a tender in response to such a specification is, at all hazards, to keep the price low, and that what the contractor has to do is to show the largest output for the least money.

When that day comes (and in my opinion it is not far off) the only reason the system ever had, *i.e.*, getting the consulting work done for nothing, will have gone; because no contractor will be foolish enough to prepare a tender on an engineering basis, taking account of low cost of working and upkeep, ease and cheapness of extension, and general suitability; when it will probably be judged on the uncommercial basis of first cost.

I have assumed that this form of specification might, under certain circumstances, have the saving grace of getting its consulting work done for nothing. I suppose this must be allowed; but I venture to suggest that the value of the work is less than is paid for it.

The best scheme is that which will soonest be on a paying basis, and it will require all a skilled and experienced electrical engineer knows, with all the help he can obtain from the local knowledge of his committee (of which he must freely avail himself) to arrive at an approximate solution of the problem of providing such a scheme.

The form of specification we are considering, ingeniously makes this combination of professional skill and local knowledge impossible. More than that, it absolutely prevents the possibility of professional skill playing any part in the scheme, so far as making it pay is concerned; because the committee has fixed the length of mains and the plant capacity (which determines the first cost); the position of the central station and the fixed law of gravitation towards the lowest first cost determines the system, and negatives the skill of the contractor; the price of labour and materials is fixed by local circumstances (which determines the running cost); and the temperament and habits of the inhabitants determines the revenue.

This is the reason why a consulting engineer, if called in to adjudicate upon tenders received in response to such a specification as we are considering, will probably advise the rejection of all of them, and a fresh start from a rational basis.

I submit, then, that this form of specification is wholly bad; bad for the ratepayers of the town adopting it, who do not get the best value for the money spent; bad for the industry in the immediate present, because it tends to cut-throat competition towards lowest first cost; and bad for it in the future, because what the industry needs is to show that it can earn dividends, and this result is not likely to be reached in the shortest time on a large scale by the multiplication of schemes which are inevitably determined in first cost, running cost, and revenue by the haphazard figures given by a committee presumably not acquainted with the science, and certainly ignorant of the fact that the figures they give so lightly have such far-reaching influence.

(*To be continued.*)

NEW PATENTS—1893.

3,146. "Improvements in diaphragms for telephones." G. L. Anders and W. Kottgen. Dated February 13th.

3,152. "An improved electrical pendulum indicator." E. Beal. Dated February 13th.

3,185. "Improvements in apparatus for recording and reproducing sounds." J. R. Quain. Dated February 13th.

3,200. "Improvements in fixing electric conducting wires to the insulators supporting same." P. R. Schomburg. Dated February 13th. (*Complete.*)

3,210. "Improvements in primary batteries and in miners' and like portable lamps." S. W. Maquay. Dated February 13th.

3,225. "Improvements in and relating to telephonic transmitters." A. Marr. Dated February 14th.

3,274. "Improvements in electrical transformers, and in boxes or casings therefor." W. C. Johnson and S. E. Phillips. Dated February 14th.

3,278. "Improvements in electric lanterns and reflectors therefor." E. Berry and F. Harrison. Dated February 14th.

3,285. "Improvements in electric signals." F. H. Clarke. Dated February 14th. (*Complete.*)

3,343. "Improvements in the application of electric motors for driving sewing and other light machinery." F. Brown. Dated February 15th.

3,376. "Improvements in direct current dynamo machines." J. S. Fairfax. Dated February 15th.

3,387. "Improvements relating to the utilisation of electricity for heating purposes, and to apparatus therefor." J. R. Quain. Dated February 15th.

3,398. "An improved insulating material for electrical purposes, and method of preparing same." A. Gentzsch, J. Goldschmidt and E. R. von Scanavi. Dated February 15th.

3,402. "Improvements in electric meters." W. Clark. (Communicated by the firm of Hartmann and Braun, Germany.) Dated February 15th.

3,412. "Improved means for transmitting telegraphic signals through submarine and like cables." A. Muirhead and H. A. C. Saunders. Dated February 15th.

3,413. "Improvements in recording instruments for electric telegraphs." A. Muirhead and R. H. Edgar. Dated February 15th.

3,461. "A new or improved writing desk and paper roll holder combined for telephones." C. G. Nestler. Dated February 16th. (*Complete.*)

3470. "Improvements in electro-motors and dynamos." J. A. Kingdon. Dated February 16th.

3,477. "Improvements in constructing and connecting galvanic elements." H. Nehmer. Dated February 16th.

3,488. "Improvements in telephones." Sir C. S. Forbes, Bart. Dated February 16th.

3,572. "Improvements in printing telegraph receiving instruments." J. E. Wright. Dated February 17th. (*Complete.*) [Date applied for under Patents Act, 1883, Sec. 103, November 16th, 1892, being date of application in United States.]

3,573. "Improvements relating to the extraction of metals by means of electricity, and to apparatus therefor." E. Taussig. Dated February 17th.

3,590. "Improvements connected with electrical conductors and their insulation." E. Payne. Dated February 18th.

3,666. "Improvements in and relating to electricity distribution." W. Lowrie. Dated February 18th.

3,675. "Improvements in and connected with telephone transmitters." E. L. Mayer. Dated February 18th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

8,784. "Improved means of and apparatus for the transmission of telegraphic signals." S. Evershed and A. E. G. Richards. Dated May 23rd. The object of the invention is to make the correspondence between the transmitter and indicator depend, not on mechanical perfection of delicate parts, but on a simple and direct connection between the relative strength of the signalling currents, and the position of the index of the indicator. 7 claims.

9,642. "Improvements in and relating to electric arc lamps or lighting apparatus." H. Watt. Dated June 6th. Relates chiefly to the construction of an electric arc lamp in such a manner, that a solenoid or electro-magnet for striking the arc, and a smaller solenoid or electro-magnet for controlling the feeding of the carbon, are arranged in series with each other and with the arc. 6 claims.

9,652. "Improvements in the production of copper tubes by electrolysis." A. Watt. Dated June 8th. Consists in subjecting the deposit, while deposition is progressing, to the action of a hard brush, or a rubber, which, while the mandrel is revolving, presses against its surface at any desired part, but preferably upon the upper part of the revolving cylinder. 1 claim.

10,083. "An electrical safety cut-out." H. S. Keating. Dated June 13th. The inventor divides the conducting wire and introduces the end of the one into one limb of a U-bent glass tube containing mercury, in which the end of the wire is immersed. The other limb of the tube terminates in a bulb into which the end of the other wire is sealed, and in which it may be bent into a coil, its end dipping into the mercury in the tube. When the electrical current conveyed by the one wire through the mercury to the other becomes excessive, the wire in the bulb becomes heated, and the air is expanded so that the mercury in the one limb of the tube is depressed, breaking contact with the wire. 1 claim.

11,625. "Improvements in the method of, and apparatus for, making electrical connections." J. H. Holmes. Dated July 8th. Claim:—An electric coupling device formed of two or more cylinders (or their equivalent, as described), having parallel axes slightly eccentric to each other, in combination with two or more sockets slightly eccentric to each other, and so designed that when the two eccentricities coincide in direction the cylinders can freely enter the sockets, but the said cylinders shall tightly jam in the said sockets when they are rotated on their axes relatively to the sockets.

11,644. "Improvements in the lighting of trains by electricity." I. A. Timmis. Dated July 8th. Claims:—1. In the lighting of railway trains electrically the use of main and auxiliary lamps with main and auxiliary supplies of electricity in conjunction with two or three through main leads, substantially as and for the purposes described. 2. In the lighting of railway trains electrically the use of main and auxiliary lamps, together with a main supply of electricity and auxiliary batteries, substantially as and for the purposes described.

11,767. "Improvements in telephone switchboards." J. E. Kingsbury. Dated July 10th. Consists in constructing the jacks so that they project from the main fabric of the switchboard, and the plug by which connection is effected, the inventor constructs so that it shall be hollow or otherwise adapted to make the necessary contacts on the projecting points or surface. 6 claims.

12,040. "Improvements in voltmeters." A. H. Dykes and W. B. Hird. Dated July 15th. In a narrow space between the poles of a permanent horse-shoe magnet the inventors introduce the edge of a coiled bobbin of insulated wire, made in the form of a thin disc, and fixed on an eccentric axis which carries an index, and is held in the zero position by an adjustable spring or by a weight, this axis being parallel to the plane of the magnet. According as the electric current which passes through the coil has greater or less electromotive force, the bobbin is drawn more or less in between the magnet poles in opposition to the spring or weight, its index pointing to the volts on a suitable scale. 2 claims.

13,252. "Improvements in electrical contact making and breaking devices." C. Fery and E. Ducretet. Dated August 5th. The improved apparatus comprises an electro-magnet which gives passage to the exciting current from the dynamo either direct or by a derivation taken at the brushes of the dynamo. The apparatus also comprises a second coil through which all the current of the charge passes, and which is arranged to magnetise a soft iron contact lever movable about an axis; this piece of iron is placed inside the second coil and operates the said lever. When the electric machine is not running the said lever is in the position in which a spring, acting to lift the outer end of the said lever, maintains a contact point on the said outer end out of contact with a cup containing mercury, the upper face of the lever resting against a stop screw. When the dynamo is started, the electric tension increases gradually until at a certain moment it will be equal to that of the secondary battery. At this moment the attraction of the electro-magnet will be sufficient to overcome the tension of the spring, and to cause the contact point to dip into the mercury and to enable the battery to be charged. 2 claims.

13,367. "Improvements in electric telephone switches and systems." T. B. Sloper. Dated August 7th. Relates to electric telephone switches and the system of working them, the arrangement being such that any two lines of the whole system may be connected as required and the talking can be effected through the wires of the instruments of both stations. 12 claims.

13,802. "Improved electric current generator for ordinary and multiple phase alternating currents." J. Sohlman. Dated August 15th. Relates to an alternate current machine in which the reversal of the magnetism of the iron cores, and the resulting heating thereof is obviated, and in which the advantages of the machines with polar armatures (low magnetic resistance and avoidance of vortex currents in the windings, even when these are thick) are combined with those of machines with armatures without cores (constant magnetic resistance). 3 claims.

13,927. "A unison apparatus for printing telegraphs." H. Van Hoevenbergh. Dated August 18th. The inventor provides means to automatically arrest the rotating shaft of the transmitting station or instrument at a predetermined point; that is, the unison point, and to hold it in the arrested position until the rotating shaft or type wheel of the receiving instrument is brought to the corresponding or unison point, when the said transmitting shaft is automatically released by the action of the receiving instrument, and the two rotating shafts proceed in unison or correspondence. 4 claims.

14,509. "Improvements in electrical transmission of power." B. J. B. Mills. (Communicated by H. W. Leonard, of New York.) Dated August 27th. The main feature of the invention consists in energising the field magnet of the motor by a constant source of current separate from the source which supplies the armature, and regulating the speed of the motor by varying the electromotive force of the source of current which supplies the motor armature. 6 claims.

19,495. "Improvements in machines for making clay conduits for electrical and other purposes." J. J. Powers and R. Van Buren. Dated November 10th. Consists in the combination of a hydraulic cylinder, a moulding cylinder connected therewith, a removable head placed between the hydraulic and moulding cylinders, and carrying rods extending down into the moulding cylinder and forming cores for the conduits, a removable resistance head supported in the lower end of the moulding cylinder by a spider frame, and an automatic device for releasing the spider frame. It also consists in a counterpoise elevator arranged to support the spider frame, resistance head, and superposed load, and in combination with the moulding cylinder, of a hydraulic filler for introducing the clay into the moulding cylinder. 5 claims.

20,530. "Improvements in and relating to ship telegraphs." A. B. W. H. Cobbs. Dated November 25th. Has for its object to effect in an absolutely accurate and automatic manner the registration of the orders given. 2 claims.

22,370. "Improvements in nautical signals or sea telephones." E. Huber, F. J. Kneuper, and J. R. Davies. Dated December 22nd. Consists in apparatus adapted to be placed upon vessels afloat at sea or at fortresses, to be located at entrances to harbours and other places, and by means of which may be ascertained the location, distance, and movements of objects in the water, and also in apparatus by means of which persons at a distance from each other may employ systems of signalling and communication by the transmission of sound through the water. 41 claims.

CORRESPONDENCE.

Application of Transformers for Electrical Measurement.

I observe that Prof. Fleming has obtained a considerable amount of credit for his application of a transformer combined with an electricity meter for reducing the pressure to be measured, that is using a transformer to reduce the pressure on a shunt coil in a meter.

This method was invented, put into practice and patented by me about six years ago. Some writers have given me credit for the method, *e.g.*, "Swinburne's Electrical Measurements."

I employed a transformer to reduce the high pressure on the pressure coil of a wattmeter constantly in experiments and practical work at the Woodside Electrical Works in 1887 and 1888.

Rankin Kennedy.